

Sixth Annual Conference on Carbon Capture & Sequestration

clean co₂al Project

 **SaskPower**

SaskPower Clean Coal Proposal

Max Ball, Manager

May 7-10, 2007 • Sheraton Station Square • Pittsburgh, Pennsylvania

Contributors:

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Presentation Overview

- Background
- The Opportunity
- The Engineering
- The Project as Proposed

The background of the slide is a historical map titled "NOVA TOTIUS TERRARUM ORBIS GEOGRAPHICA AC HYDROGRAPHICA TABULA auct. Guiljelmo Blaeuw". The map is framed by a decorative border containing various vignettes. The top border features circular vignettes with figures and animals. The left border has rectangular vignettes of figures. The right border has rectangular vignettes of figures. The bottom border features circular vignettes with scenes of ships, buildings, and figures. The map itself shows the world with latitude and longitude lines, and various geographical features.

History Lesson

Fall 2005:

- **Canada tables GHG regulations**
- **Canada requests proposals for GHG initiatives**
- **SaskPower engaged in option studies (internally and with others)**



2006 - January

- SaskPower Assembles Clean Coal Team to prepare Commercial Proposal to be evaluated against other supply options
- Coal Exploration rigs into the field (-30C)



2006 - February

- **Engineering Resources and Manufacturers Engaged**
- **EOR Operators Contacted**
- **Project Office Opened**



2006 - September

- Oxyfuel Technology Selected



2006 - November

- Coal Negotiations Completed
- Site Selected

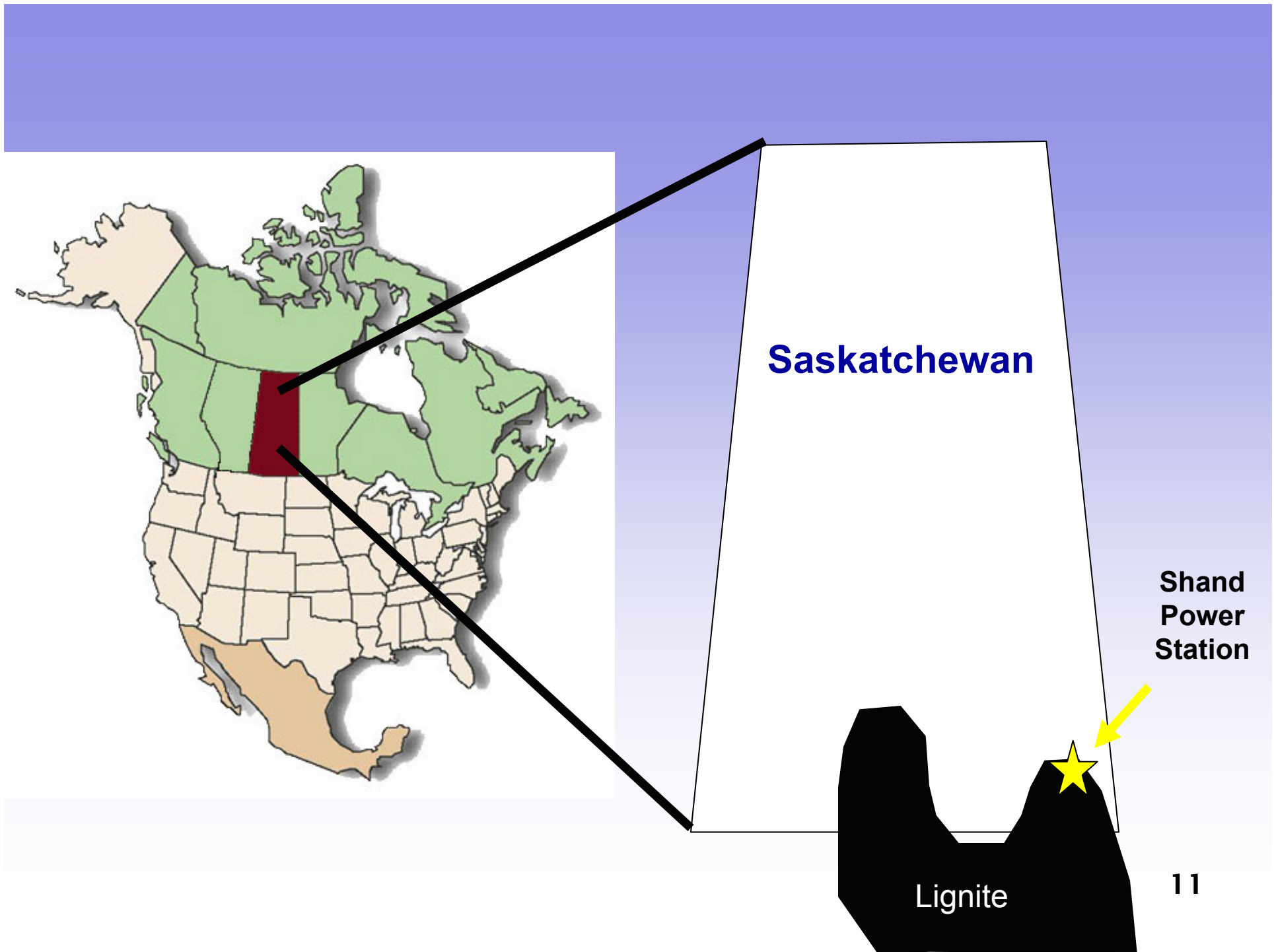


2007 - April

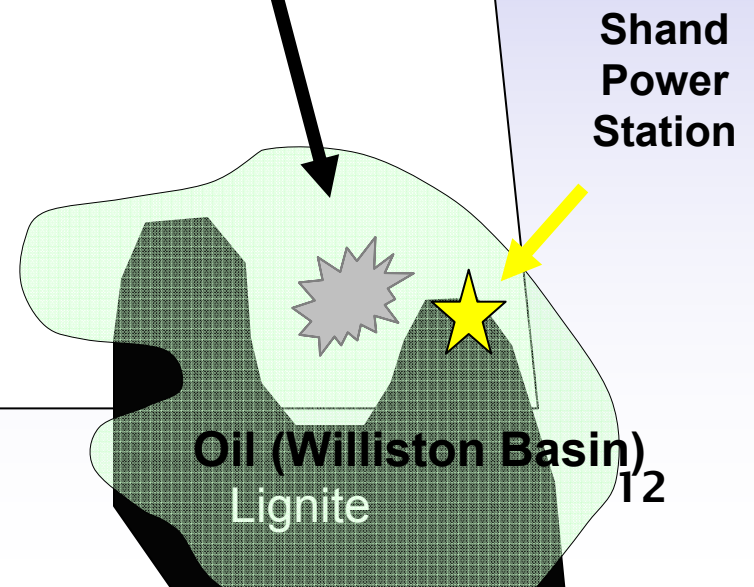
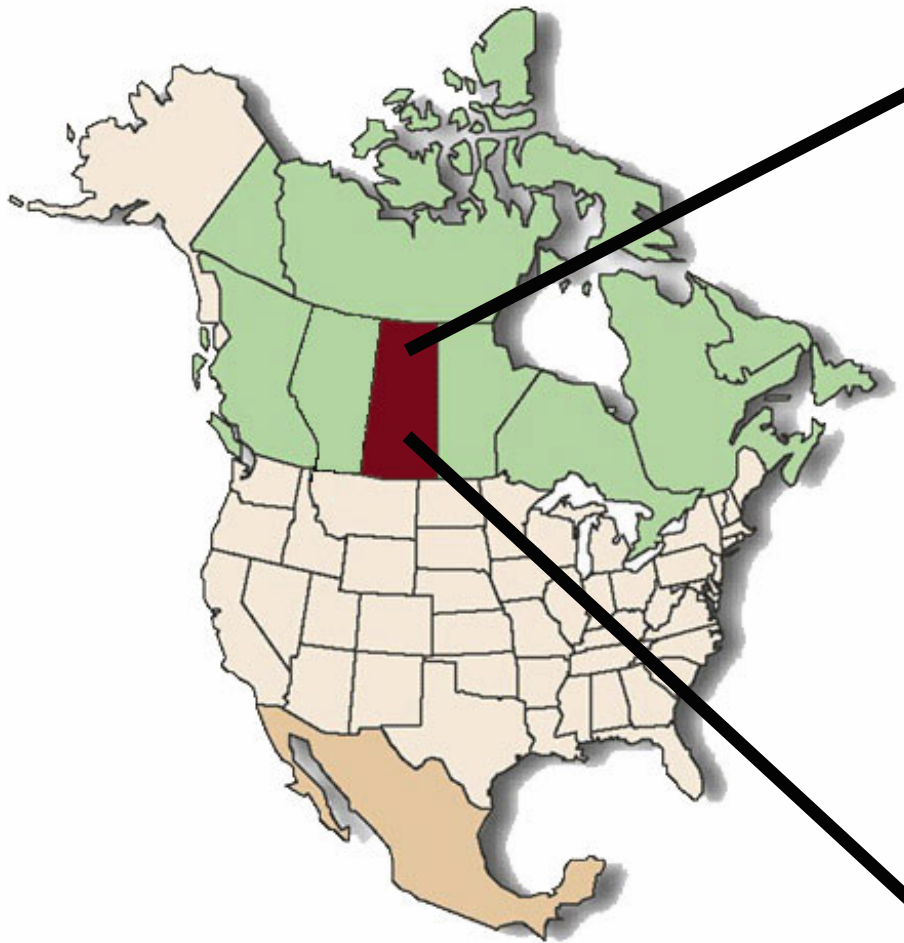
- **Technical Proposal to SaskPower**
- **Project Guidelines for EIA Received**
- **Application for Water License Submitted**

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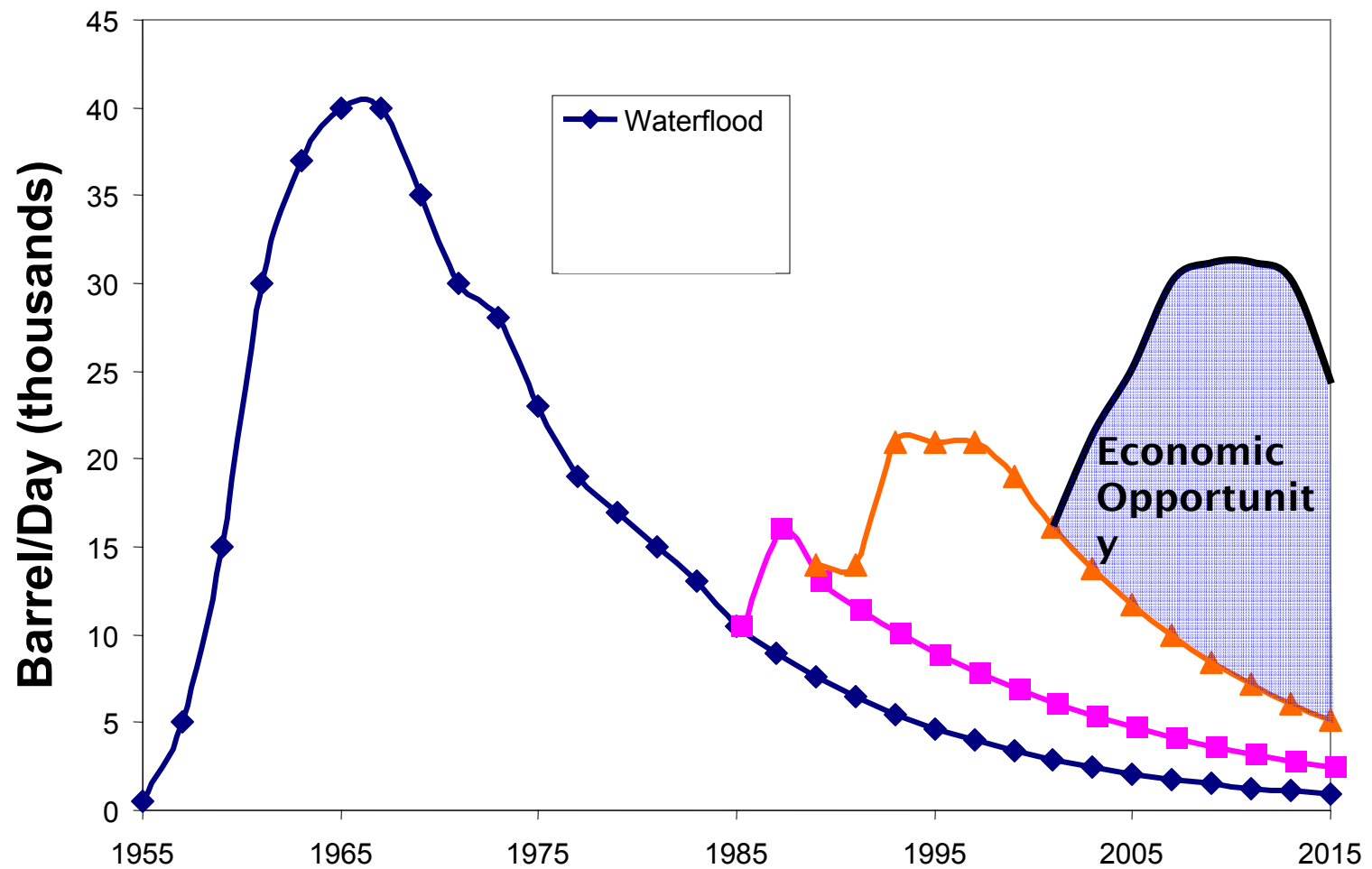
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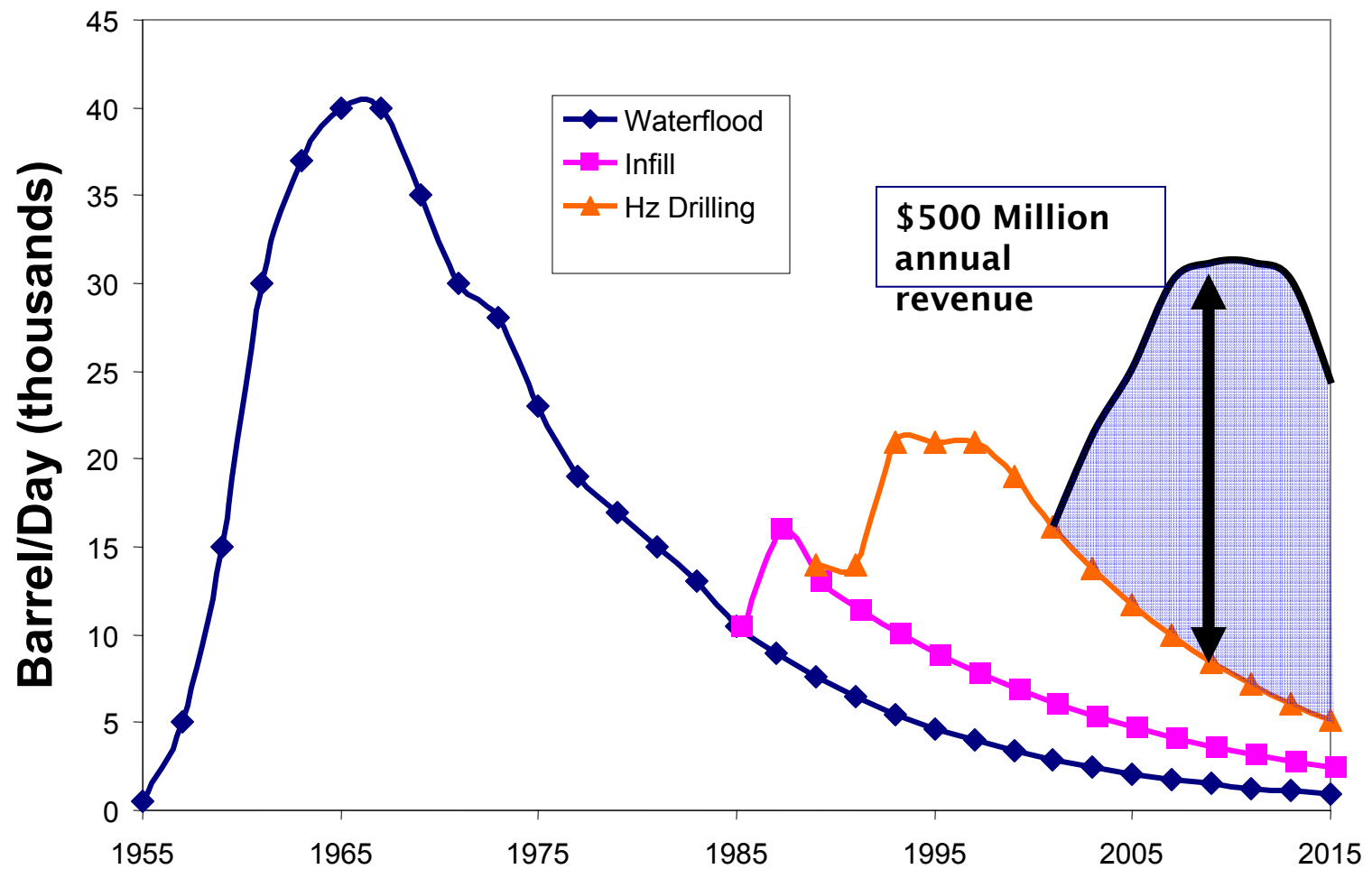
World's largest, full-scale,
in-field MMV
(Measurement, Monitor
and Verification) study
with EOR



Weyburn Pool Production History



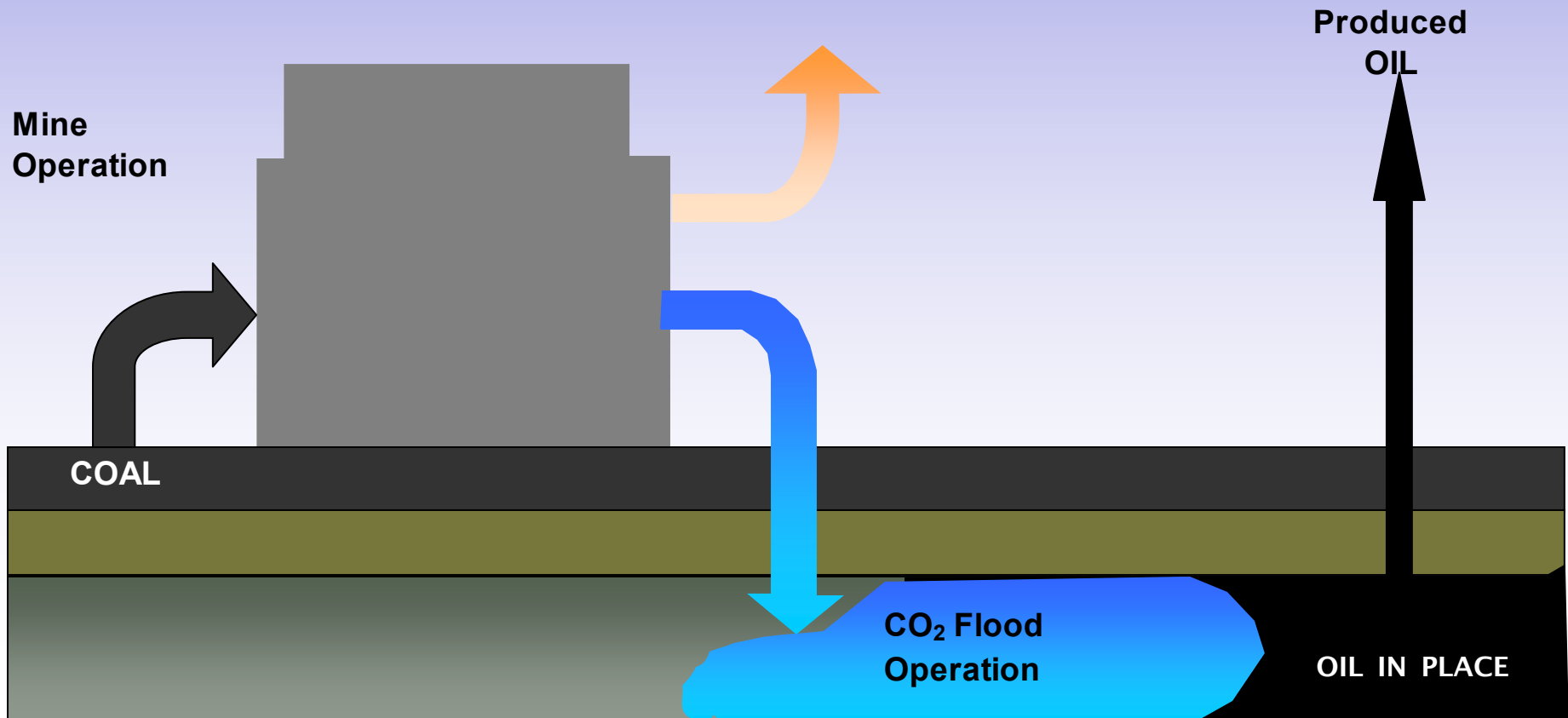
Weyburn Pool Production History



Overall COAL to OIL Process

1 Tonne Coal Produces **0.8 MWh** + **2 to 10 barrels Oil**

ELECTRICITY



ENERGY BALANCE



Energy In:

1 Tonne = - 13 GJ (fossil)

Energy Out:

0.8 MWh = + 3 GJ (electrical)

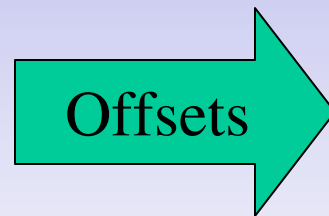
2 to 10 bbl = + 12 to 60 GJ (fossil)

Net Energy Produced: + 2 to 50 GJ (elect & fossil)

Net Emissions Impact

Near Zero emissions electricity plus:

**1 Barrel Weyburn
Crude: Equivalent
to 1.0 GHG unit**



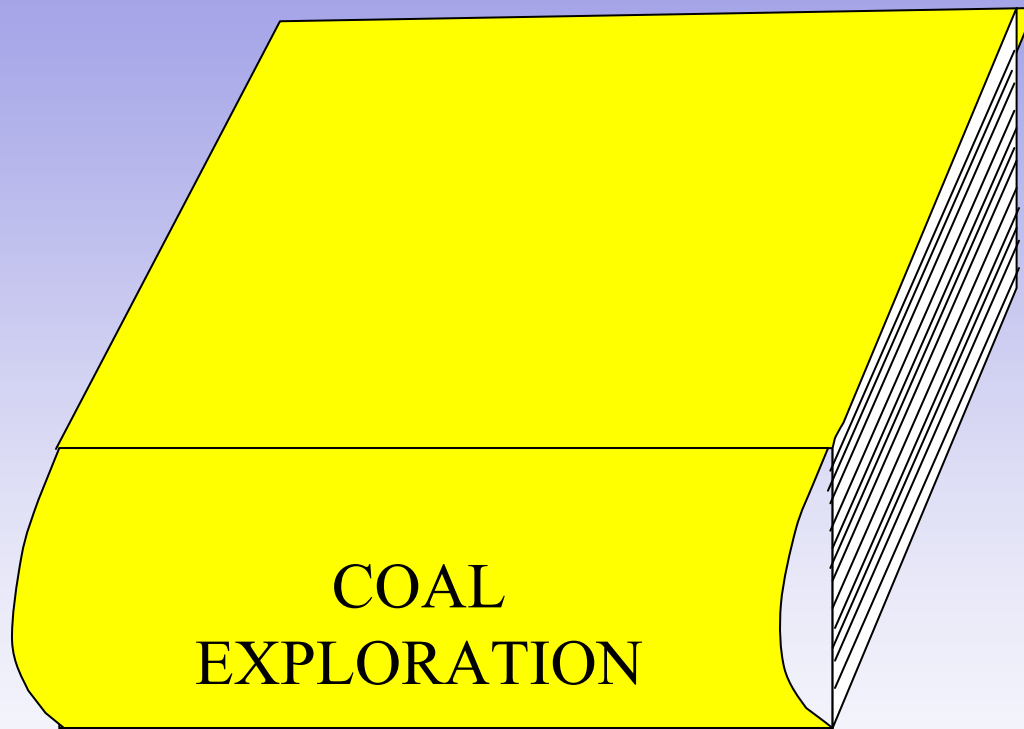
**1.3 to 1.4 GHG equivalents
Middle East Oil**

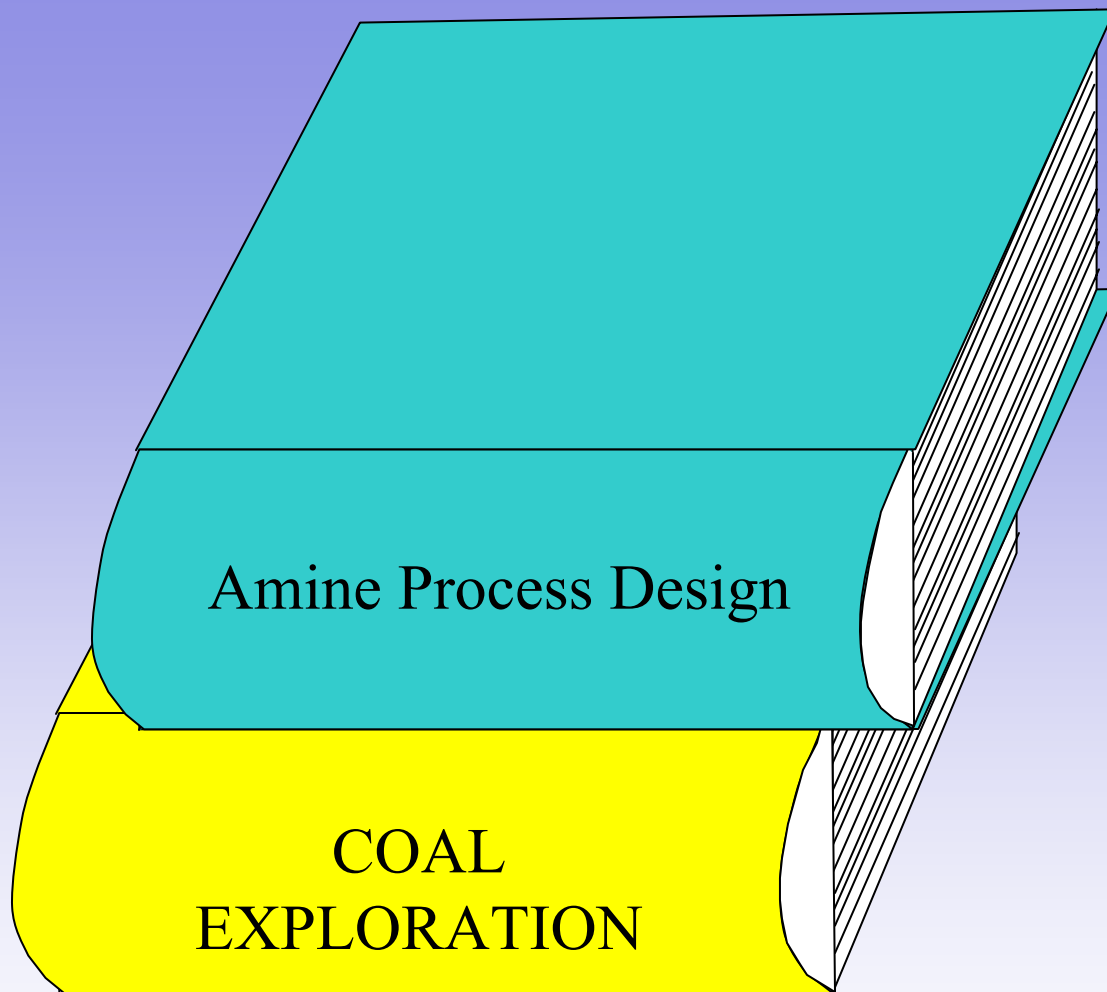
or

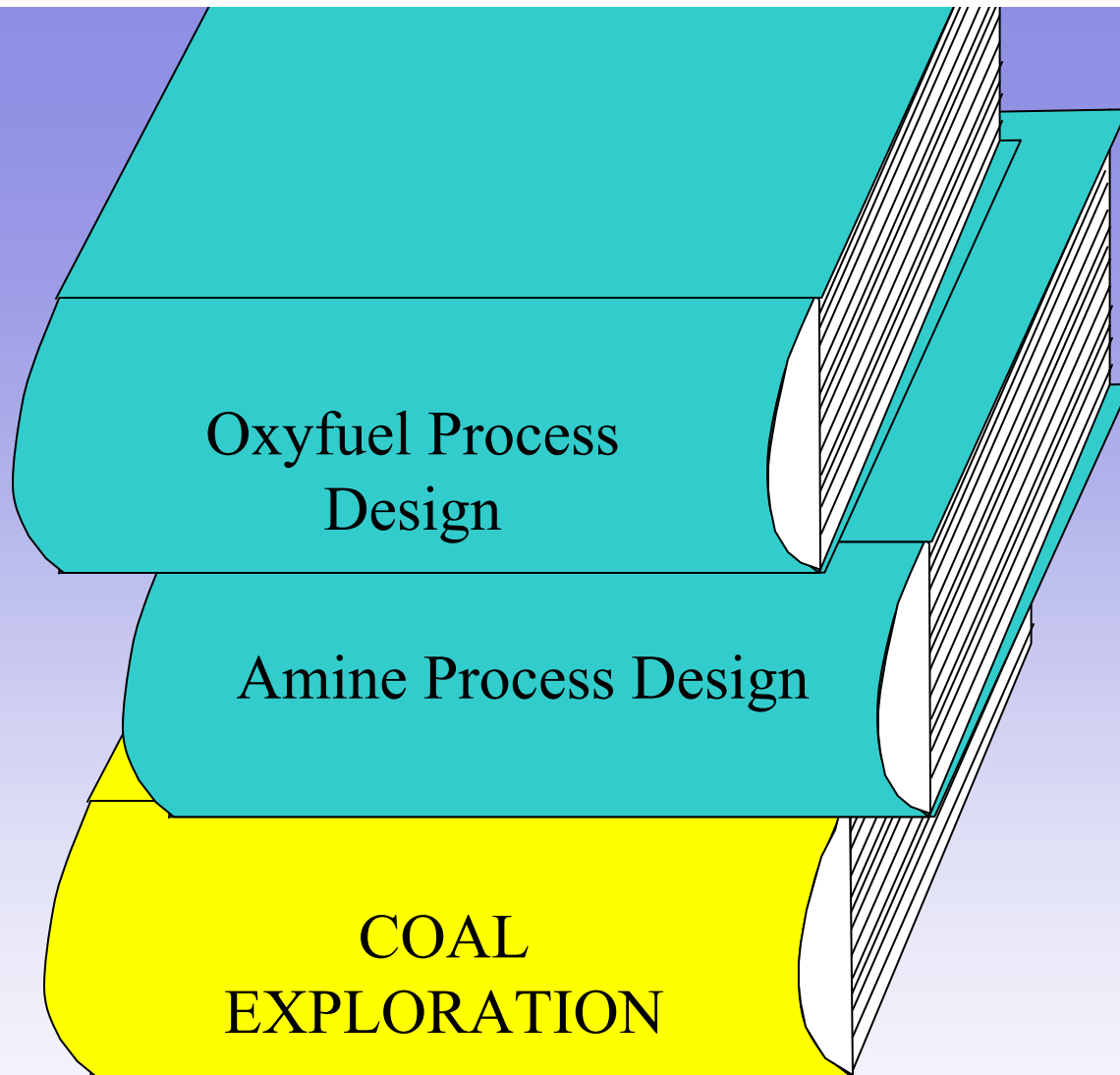
**1.9 GHG equivalents
Alberta Oil Sands**

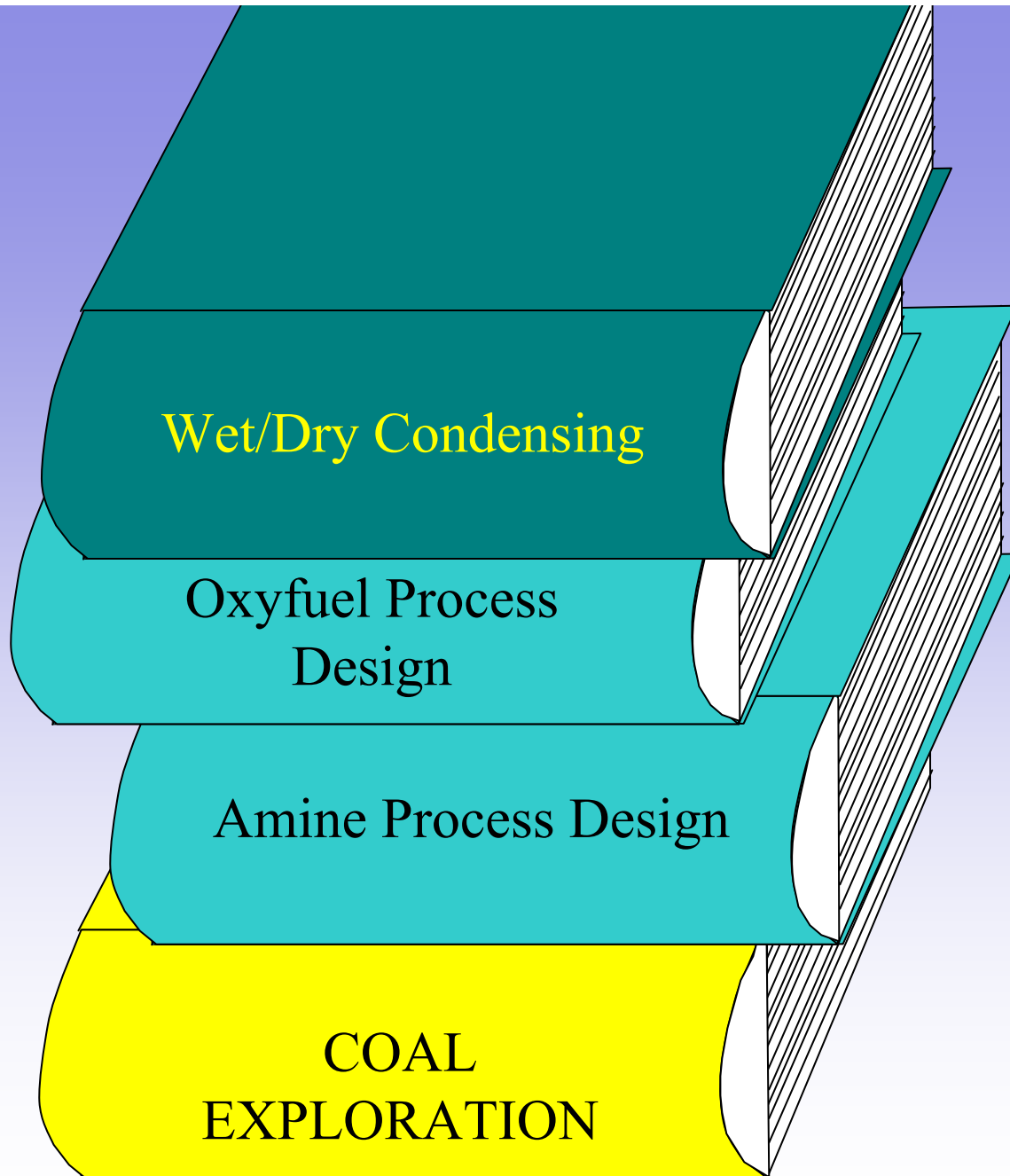
Presentation Overview

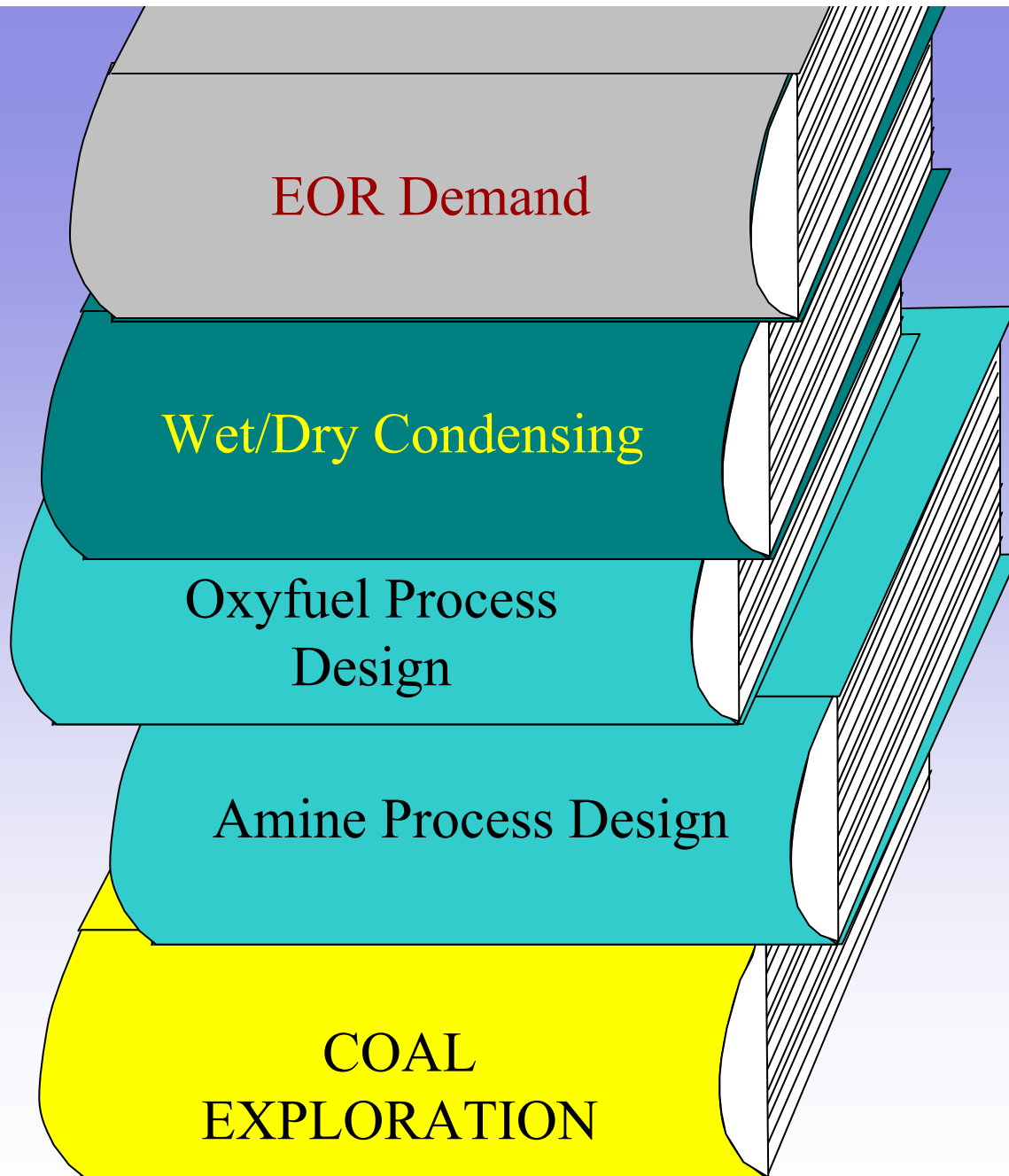
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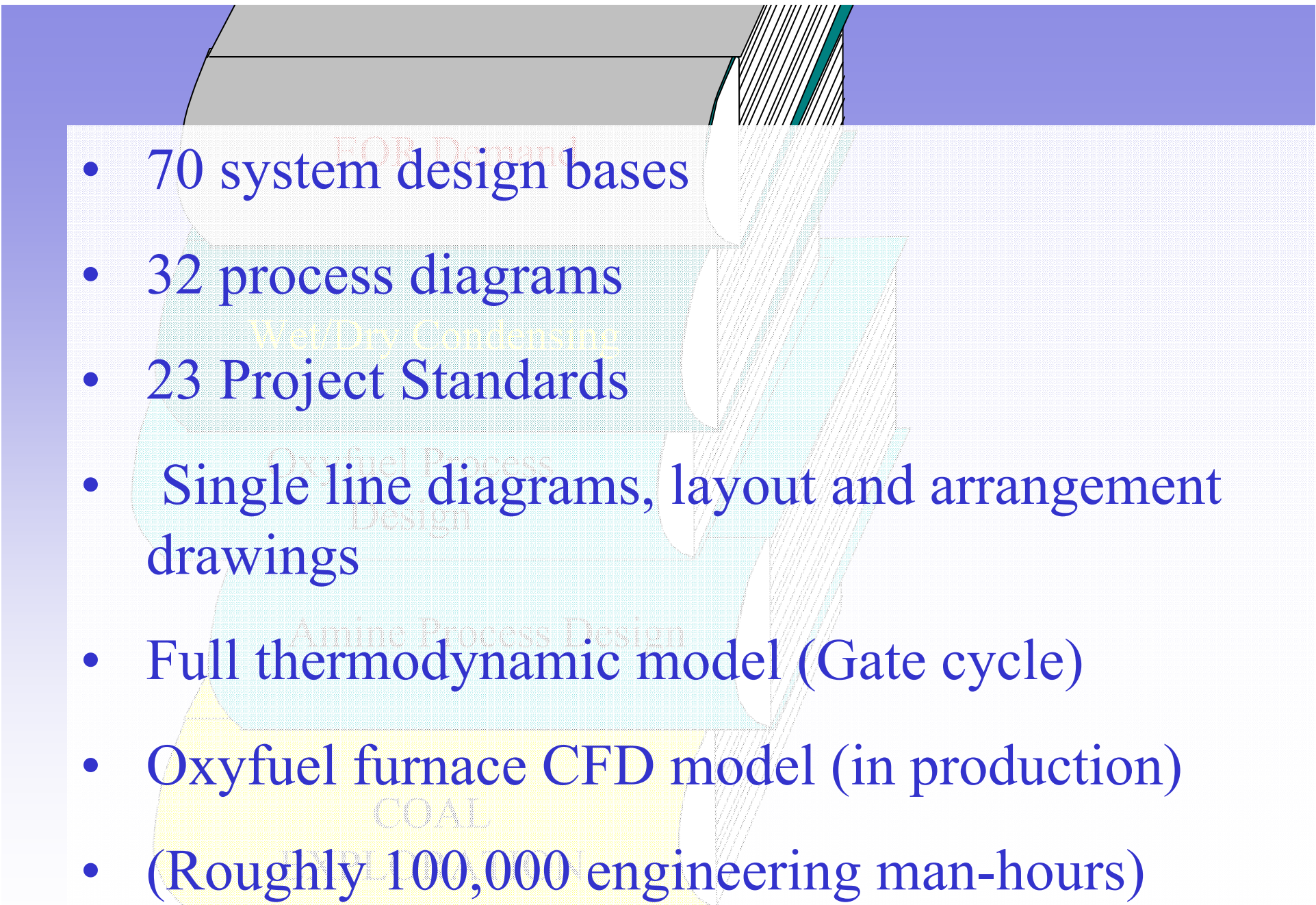






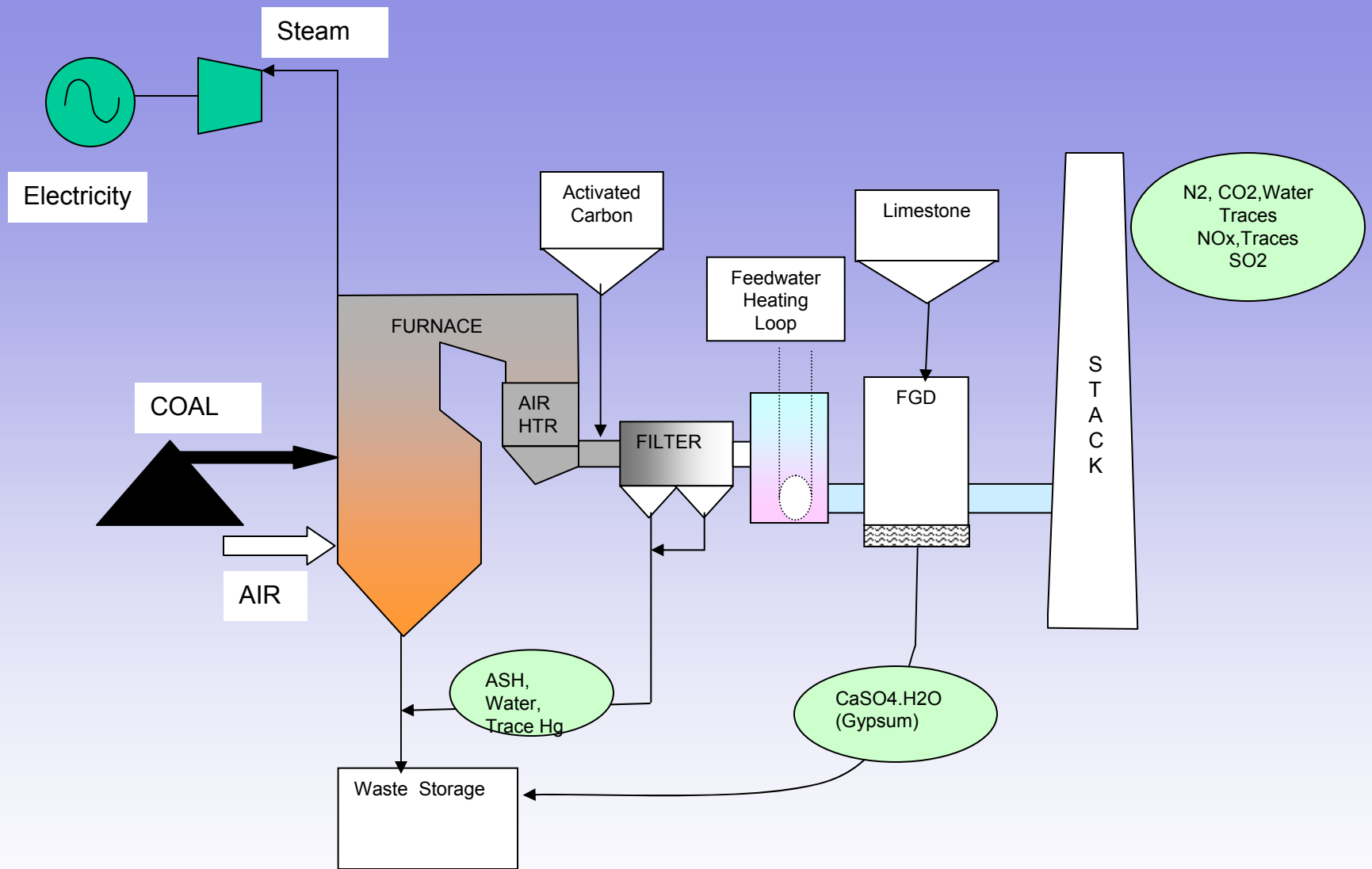




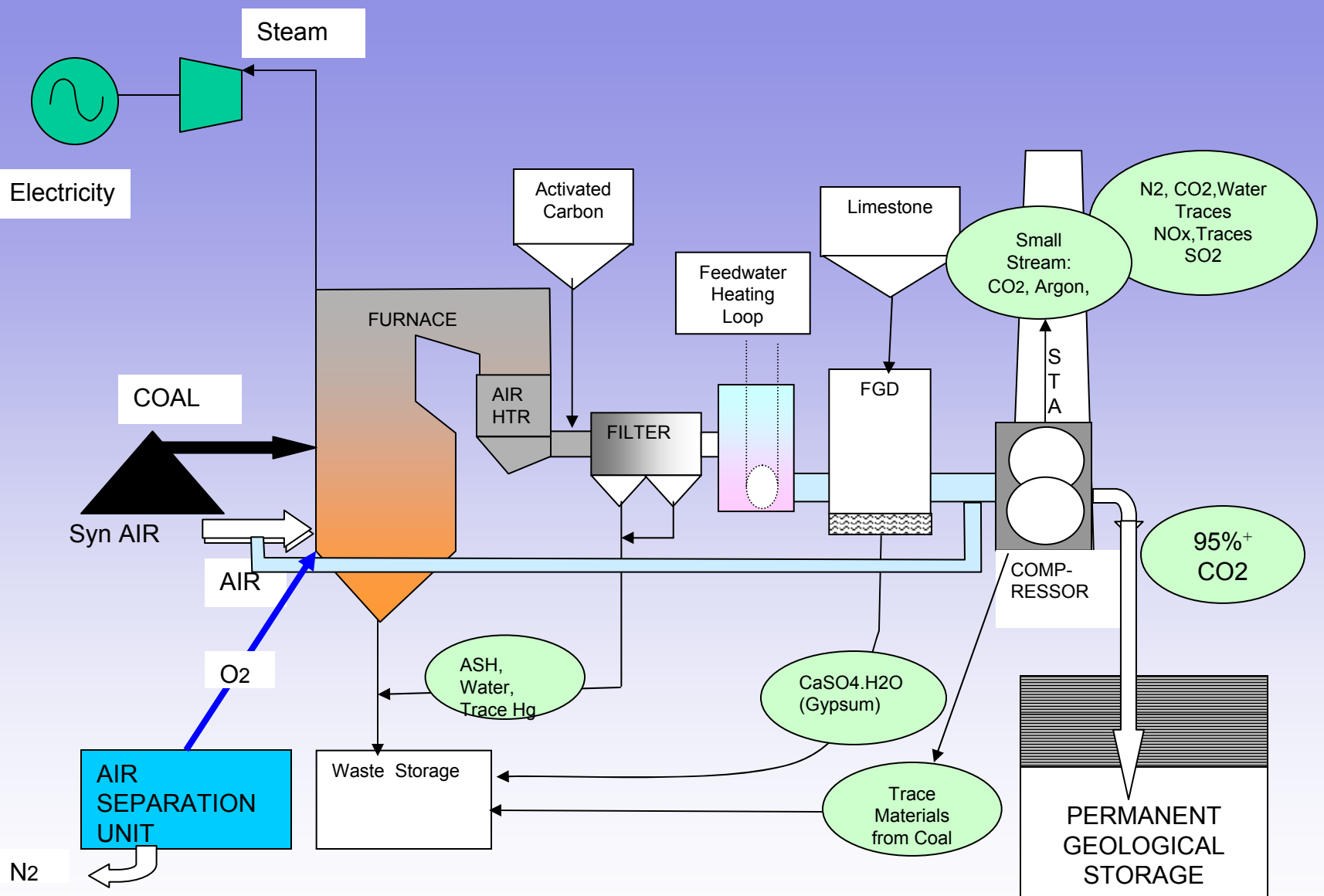
- 
- 70 system design bases
 - 32 process diagrams
 - 23 Project Standards
 - Single line diagrams, layout and arrangement drawings
 - Full thermodynamic model (Gate cycle)
 - Oxyfuel furnace CFD model (in production)
 - (Roughly 100,000 engineering man-hours)

Engineered Deliverables:

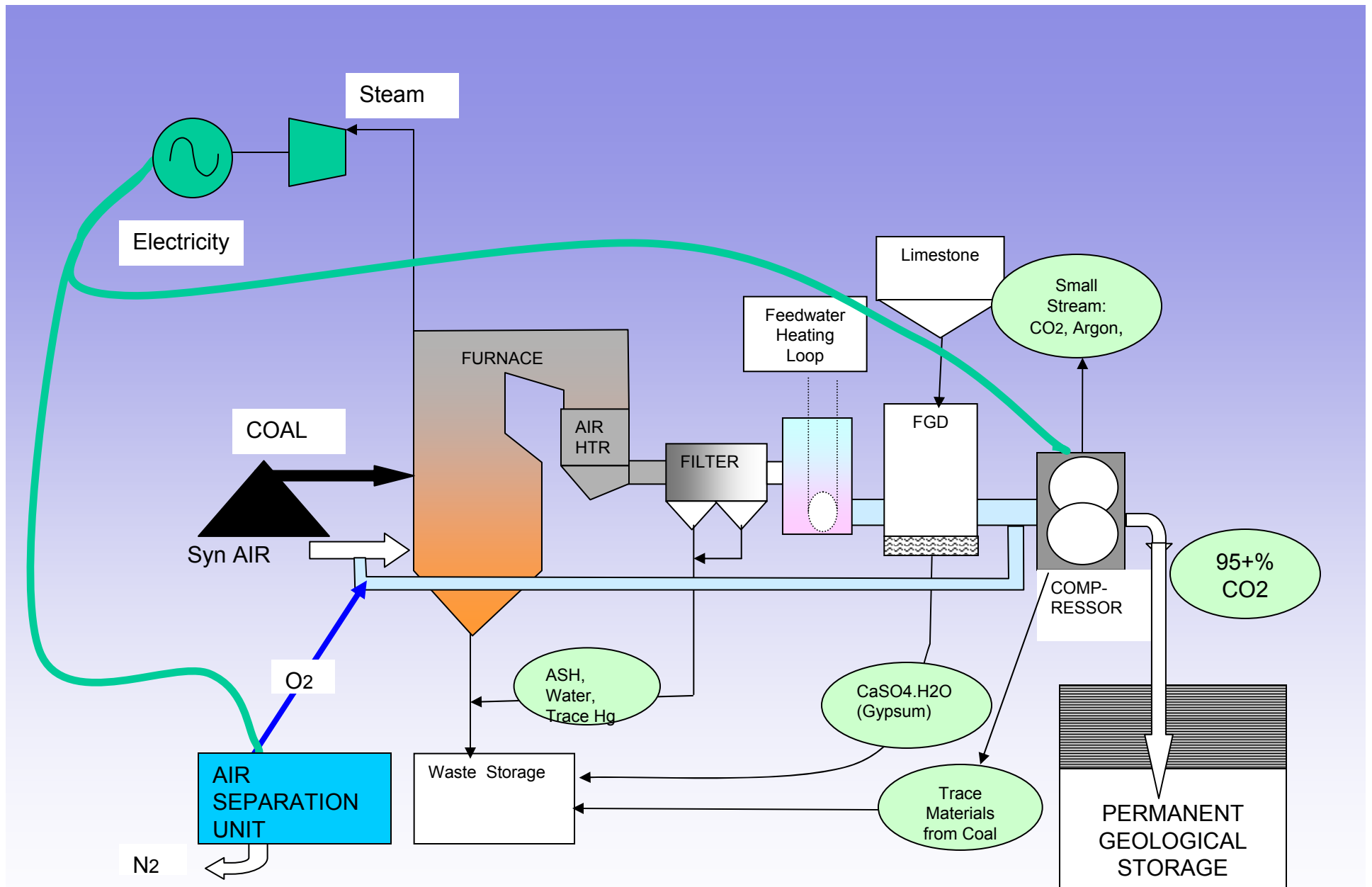
- Detailed plant design (two sites) for amine and oxyfuel with cost/performance comparison
- Detailed Oxyfuel design:
 - Full and part load
 - Air fired start up
 - Range of fuel characteristics
 - Range of ambient conditions
 - Work with available water resources
- Project Integrated Construction Schedule
- Hazop Analyses
- Structured Risk Analyses



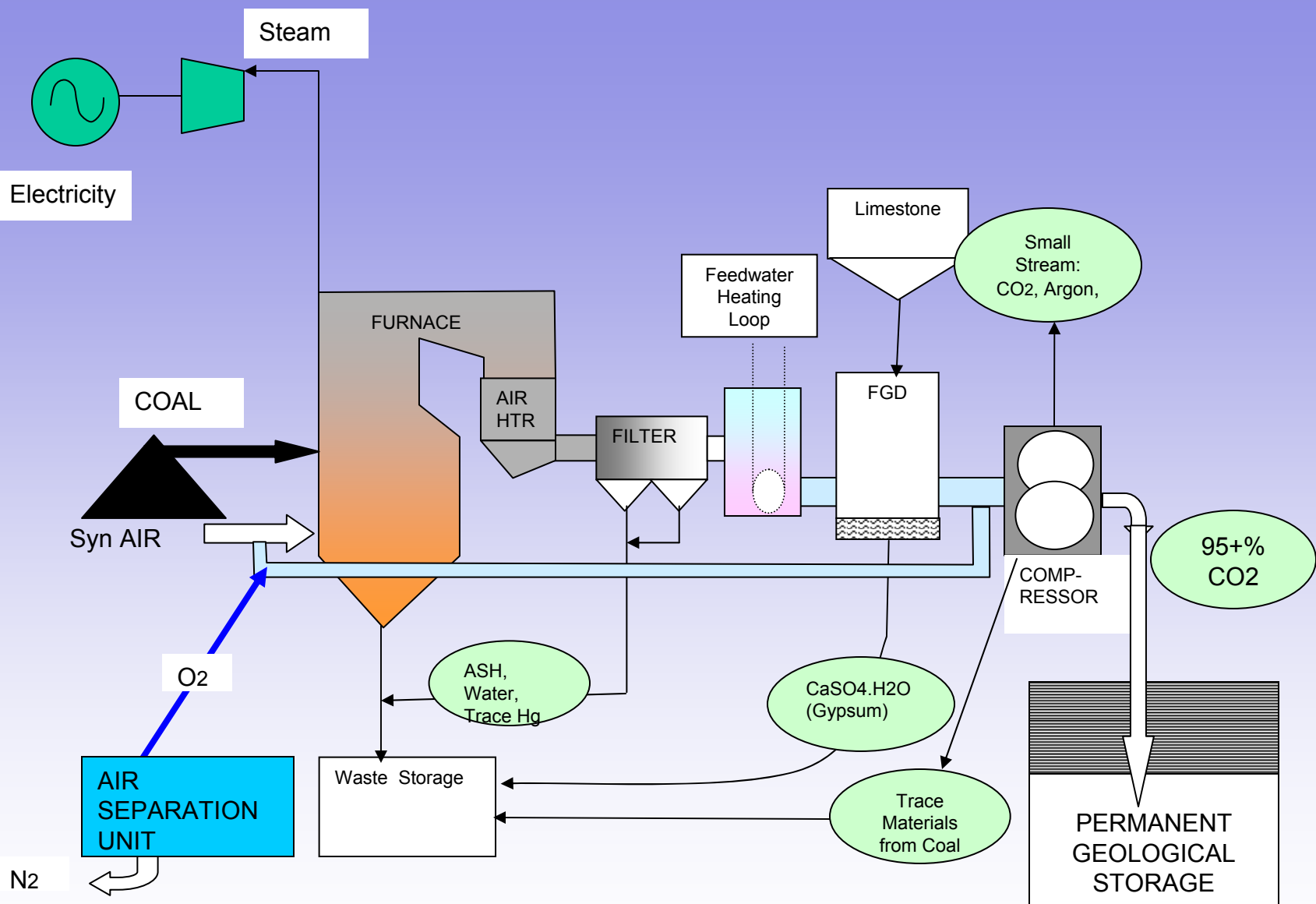
COMPLIANT COAL UNIT



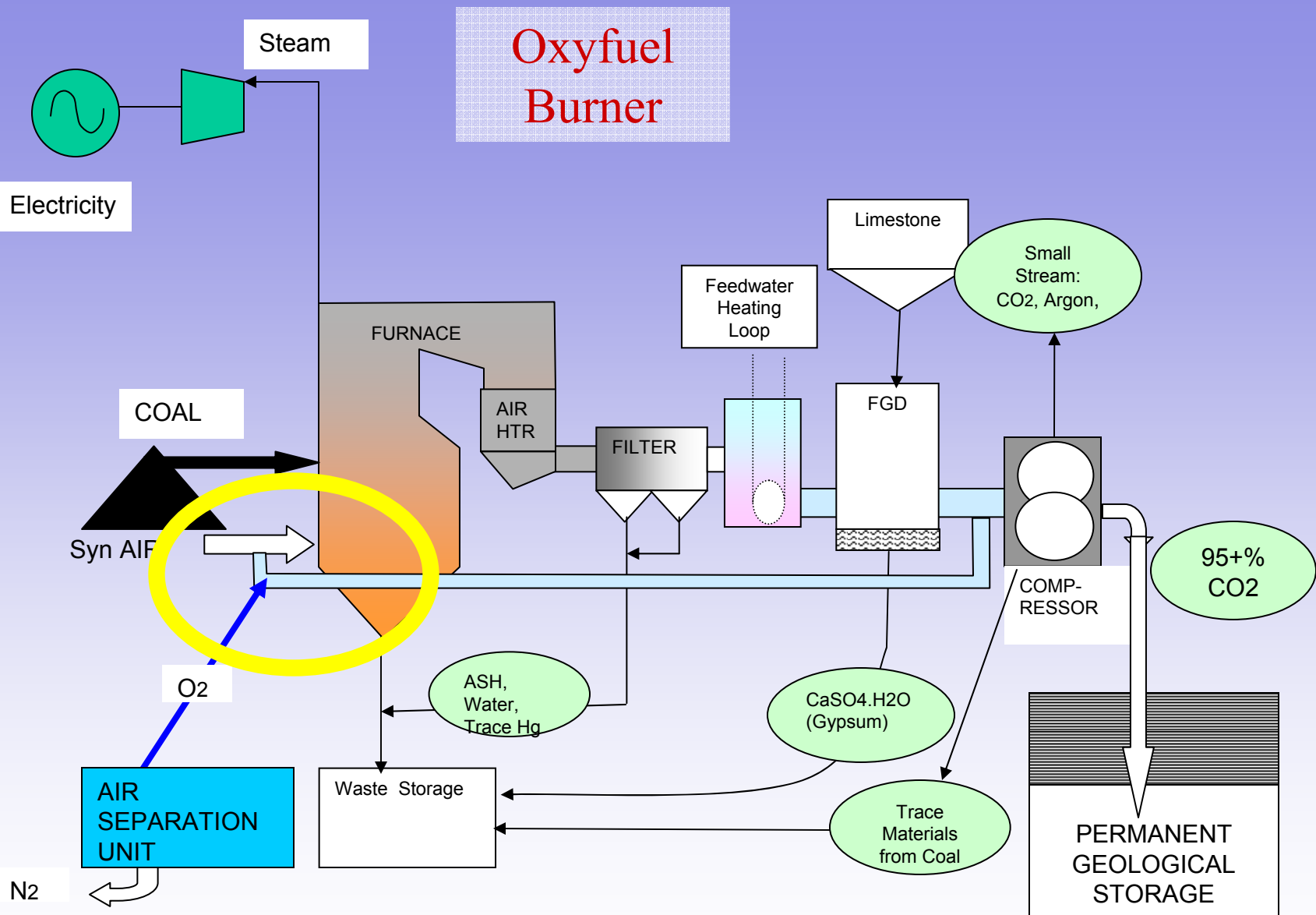
SaskPower Oxyfuel Process



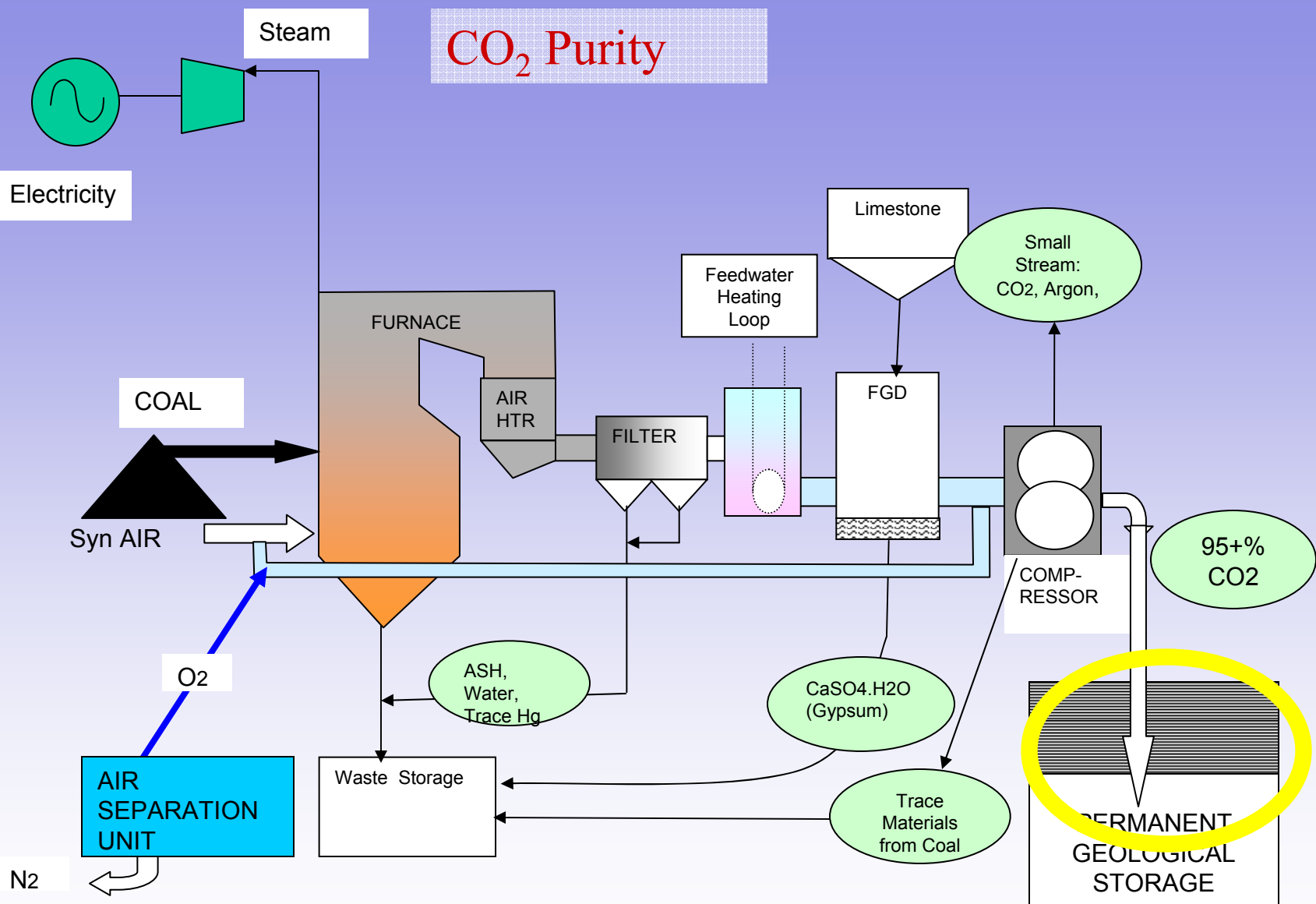
SaskPower Oxyfuel Process



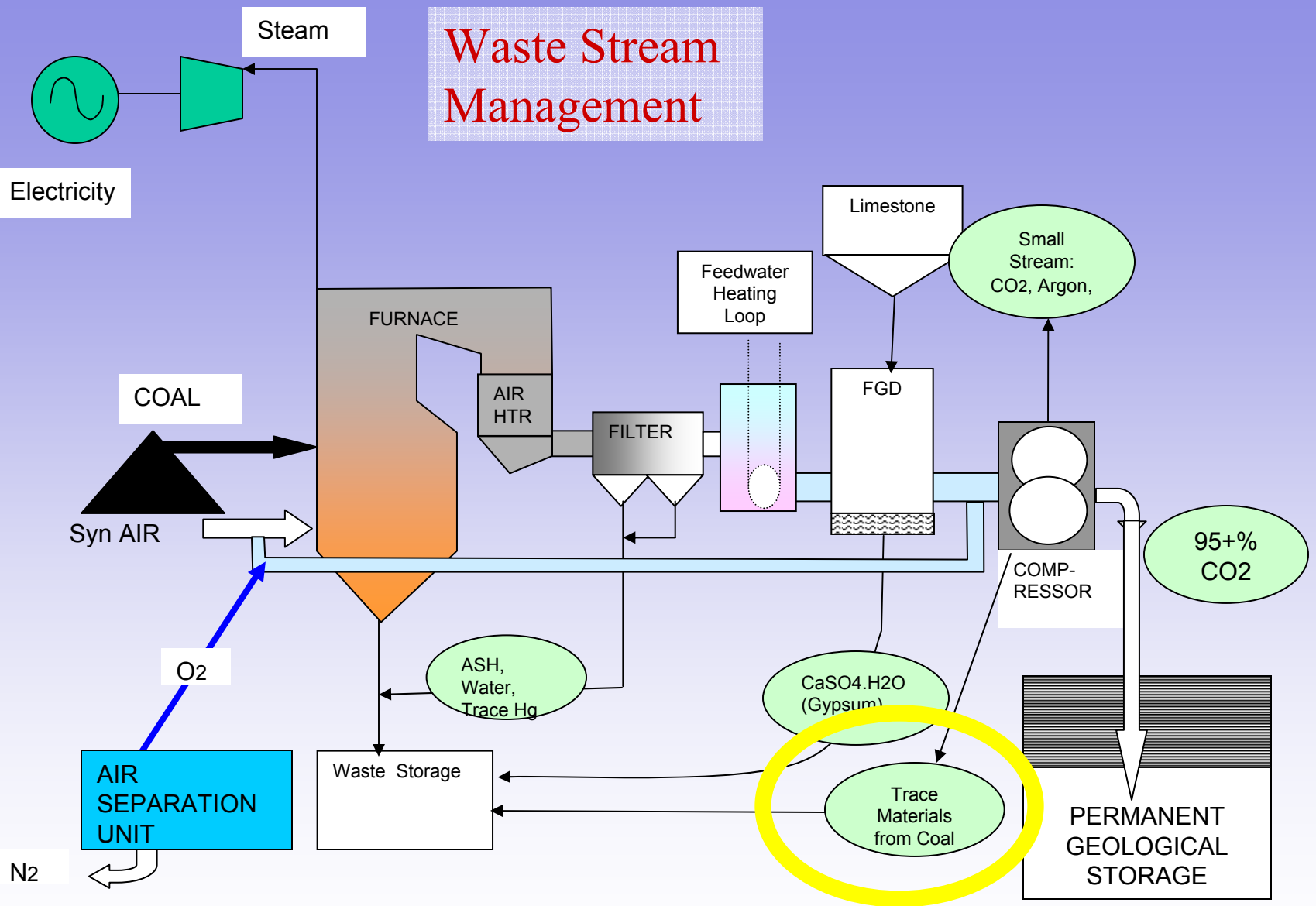
SaskPower Oxyfuel Process



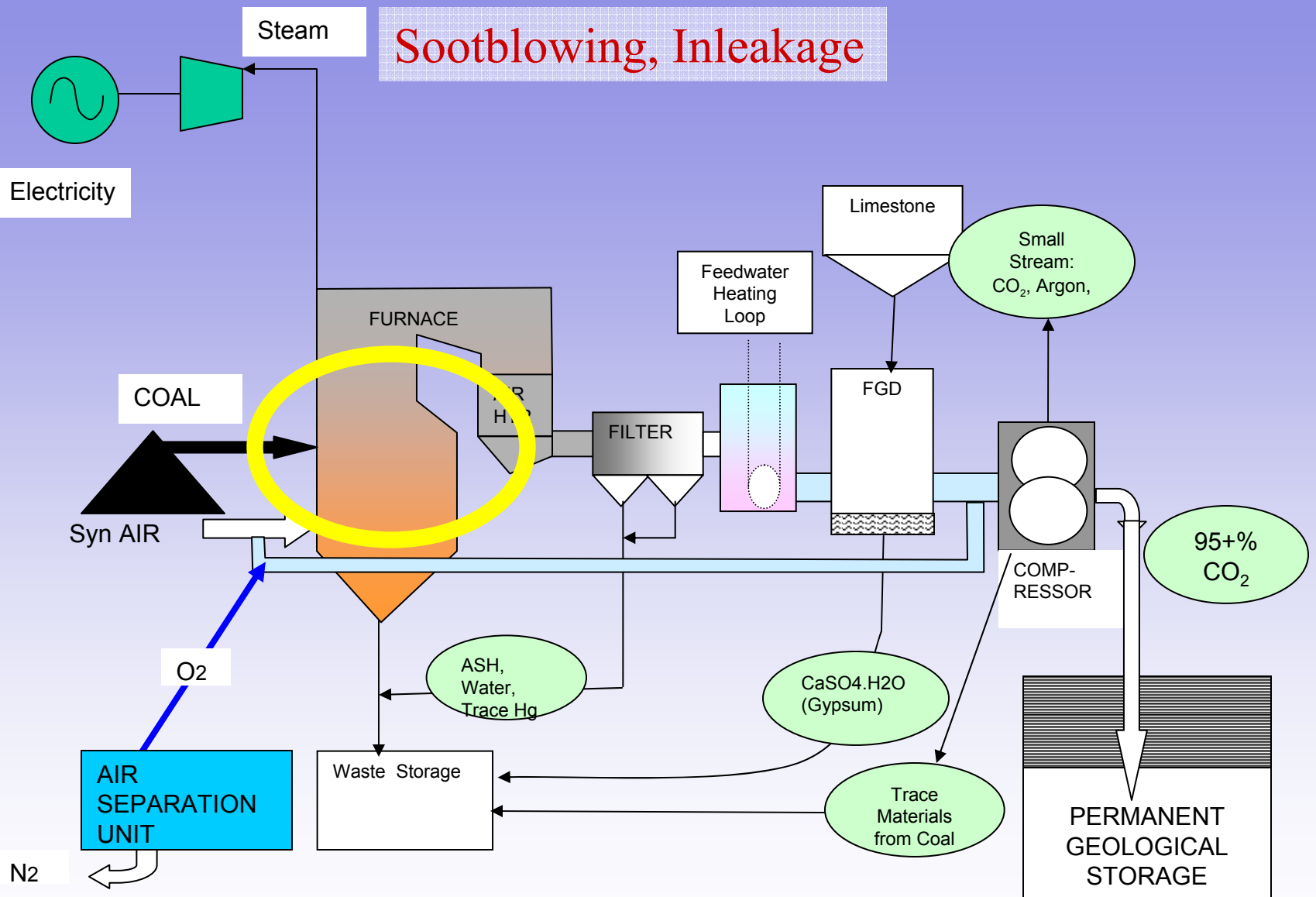
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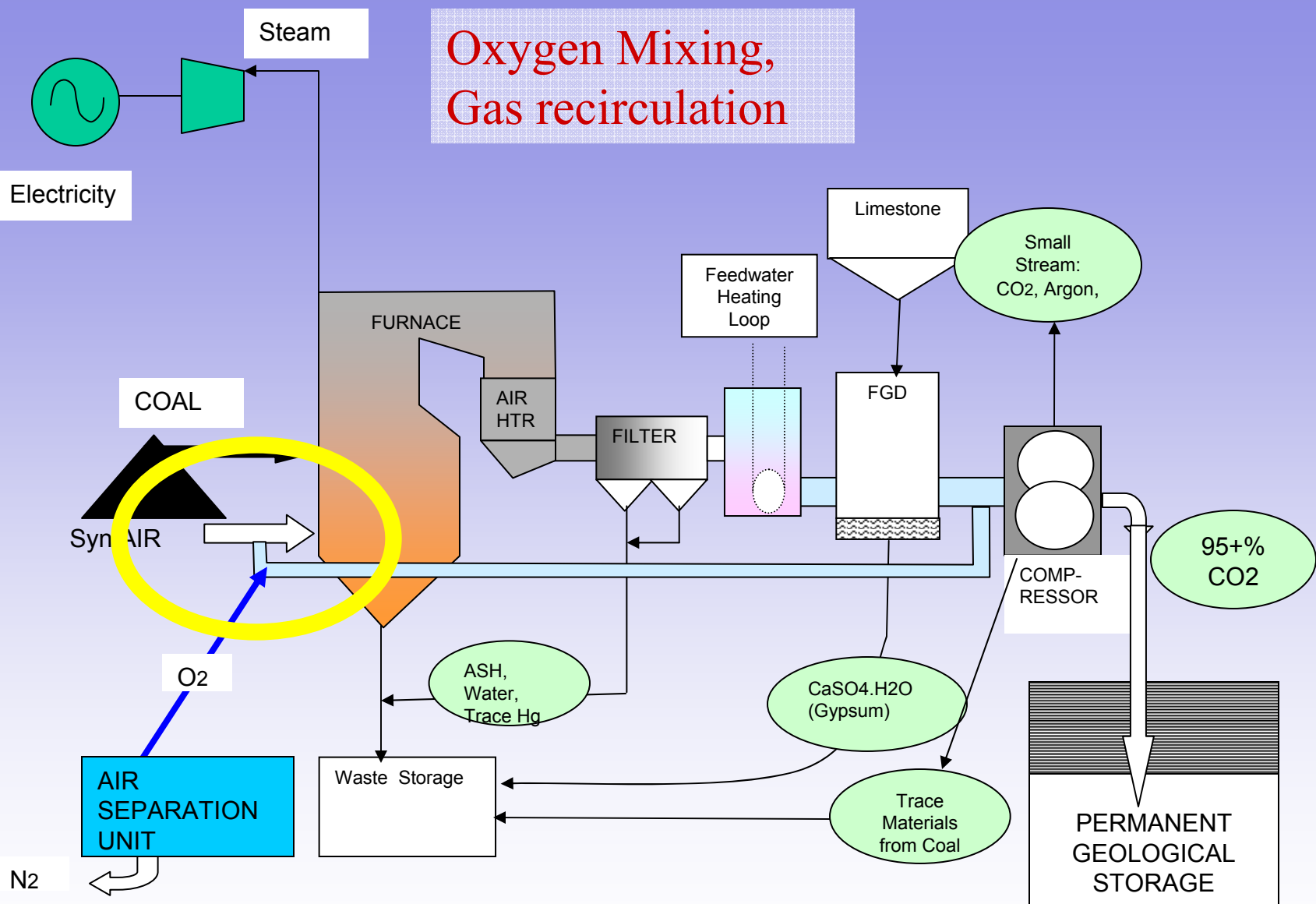
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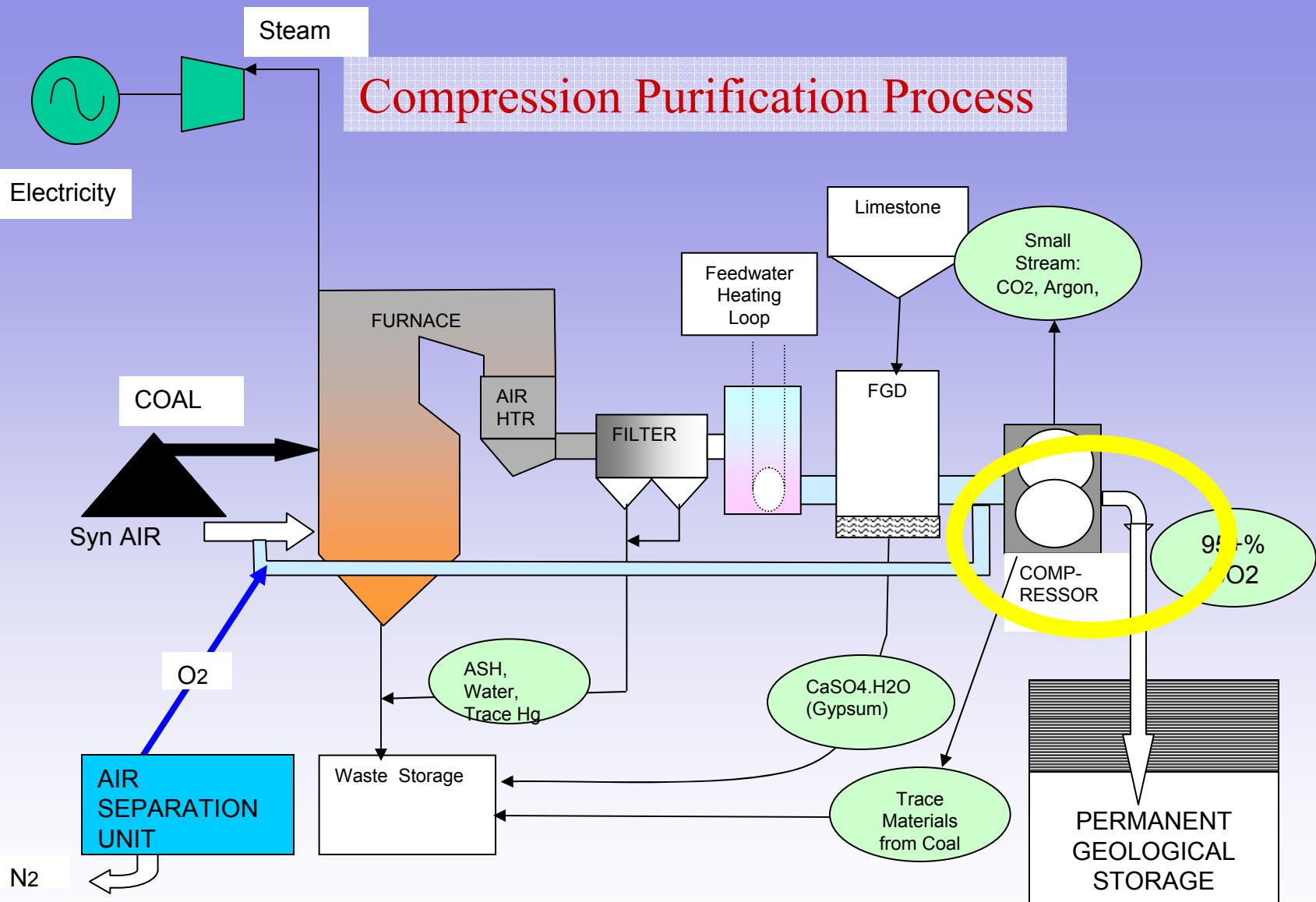
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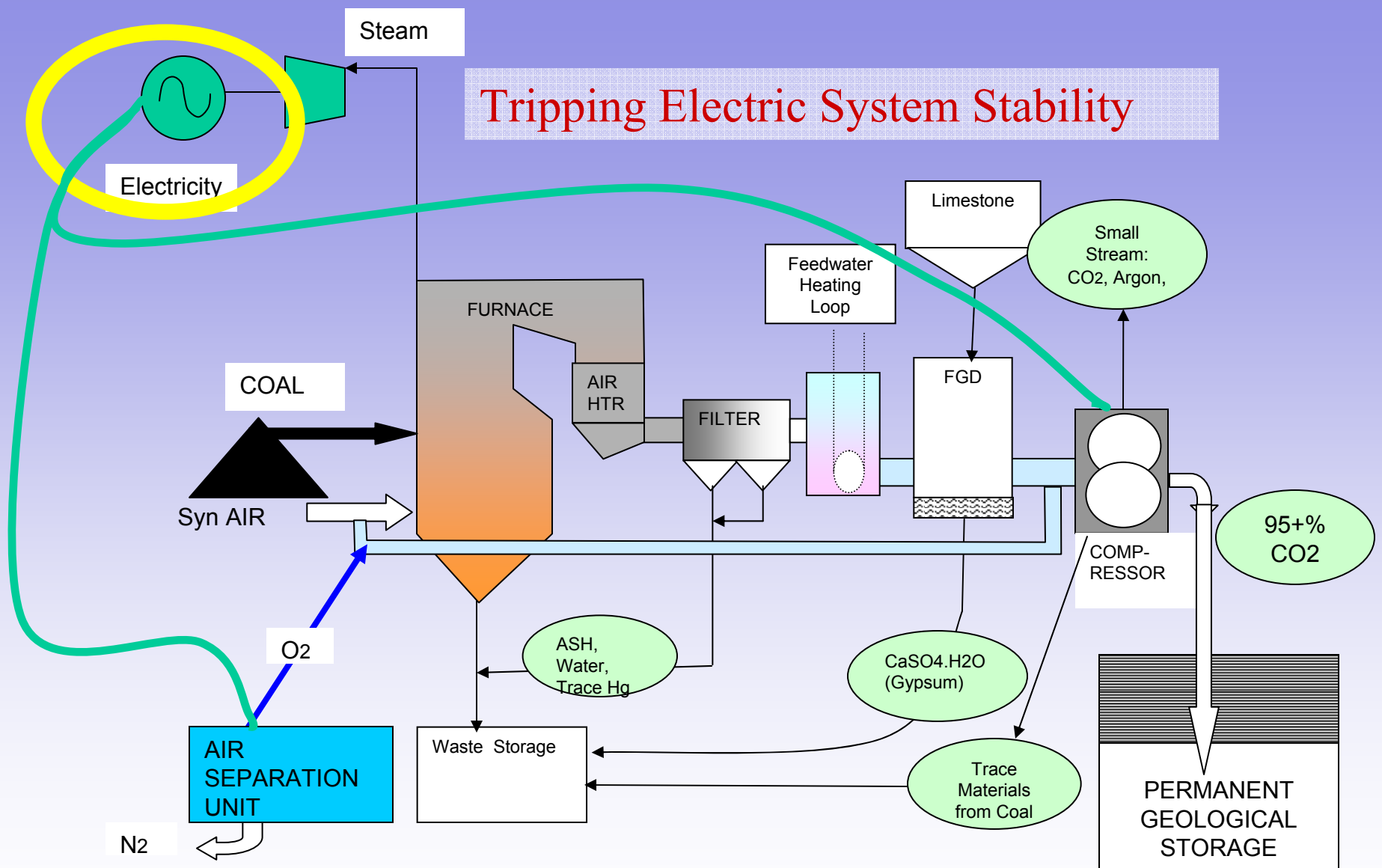
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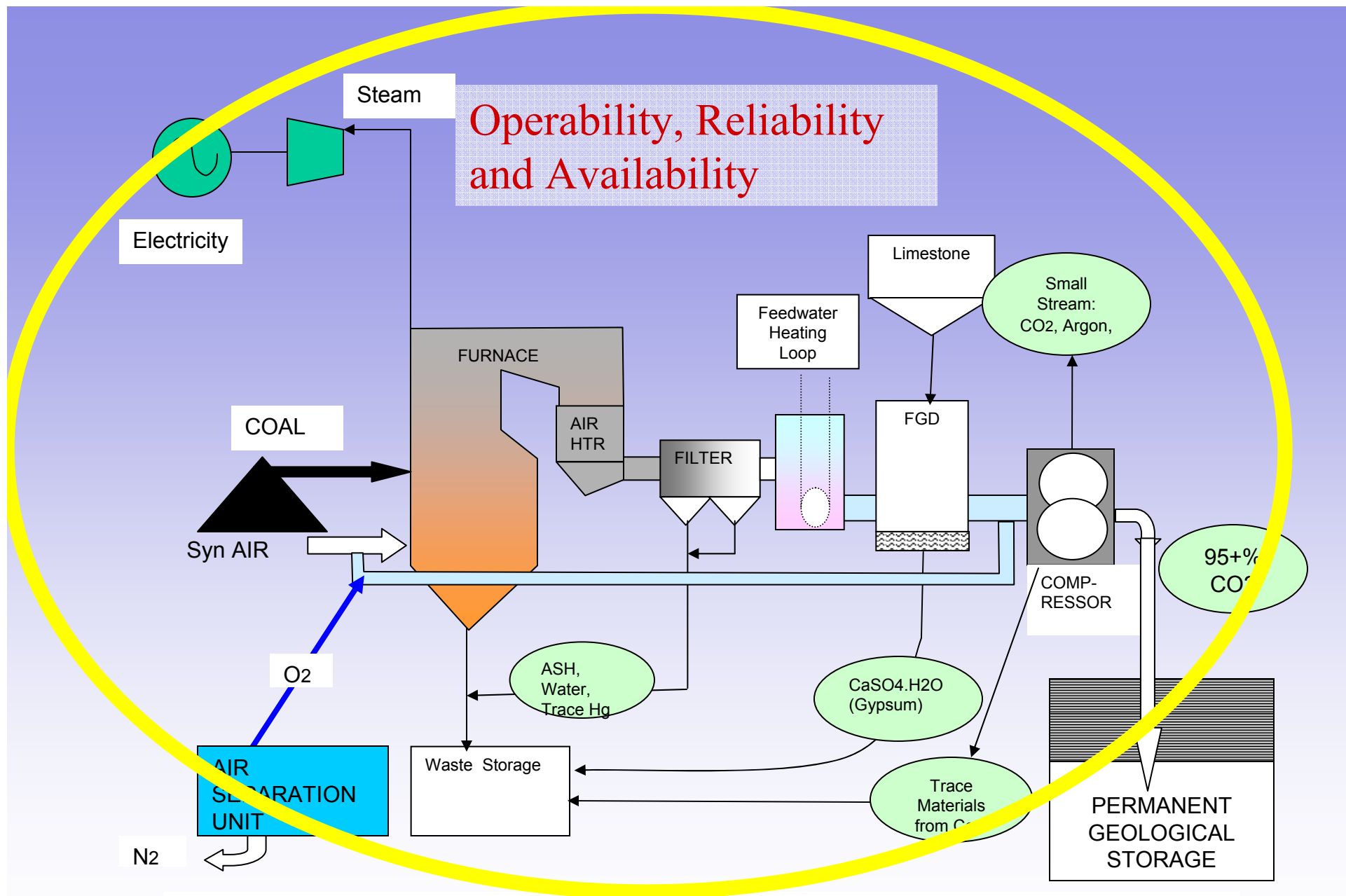
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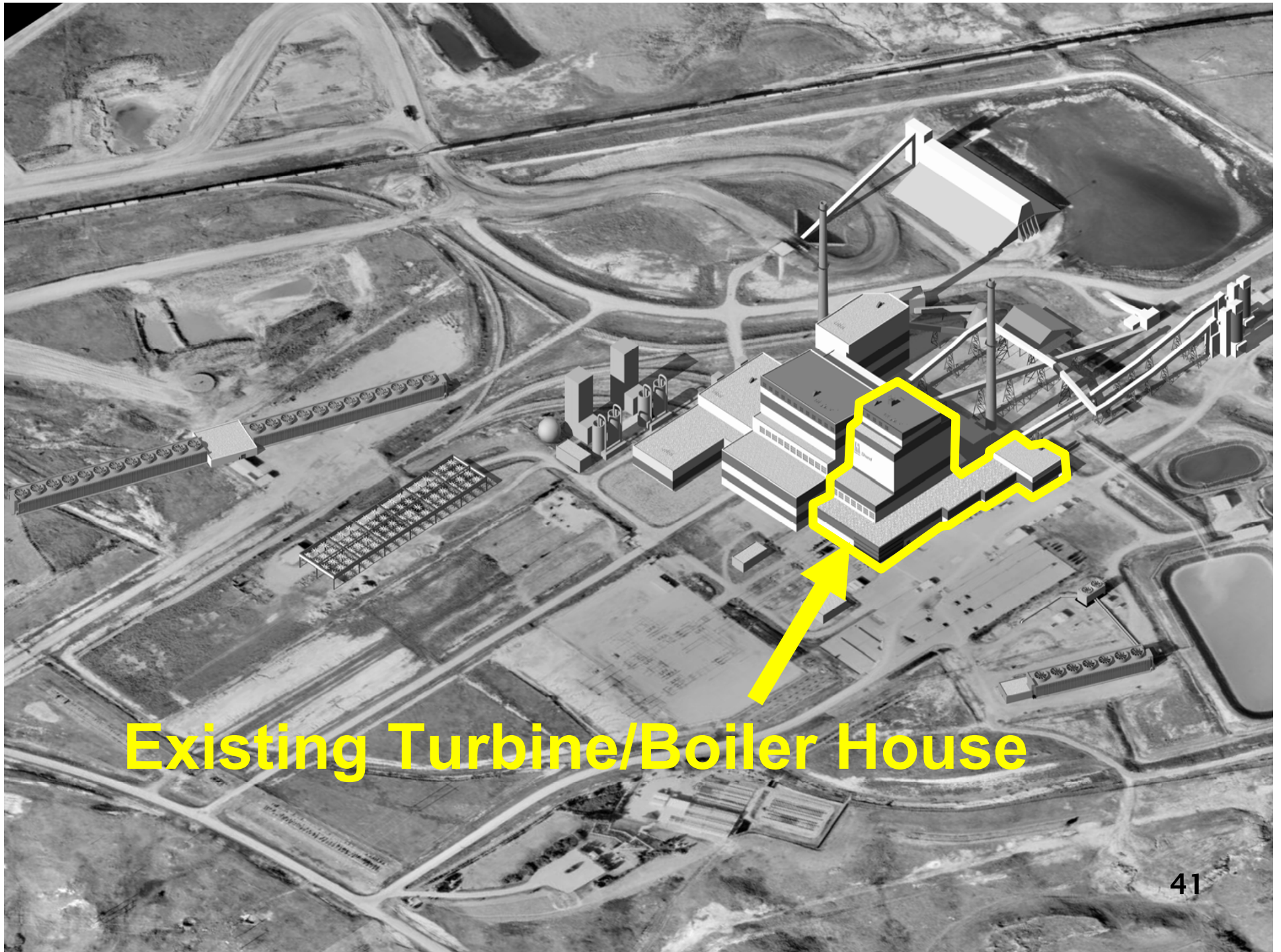


SaskPower Oxyfuel Process

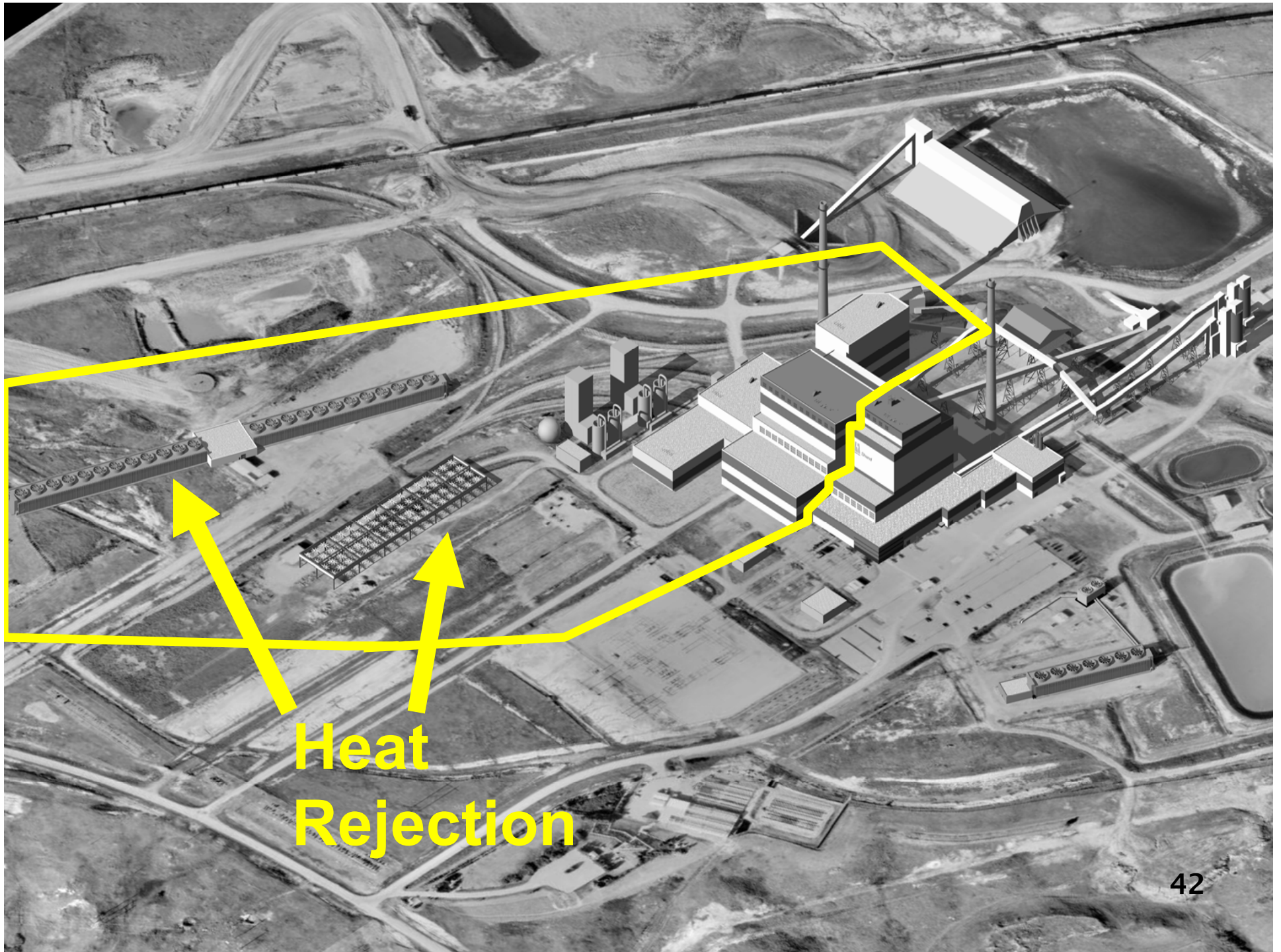
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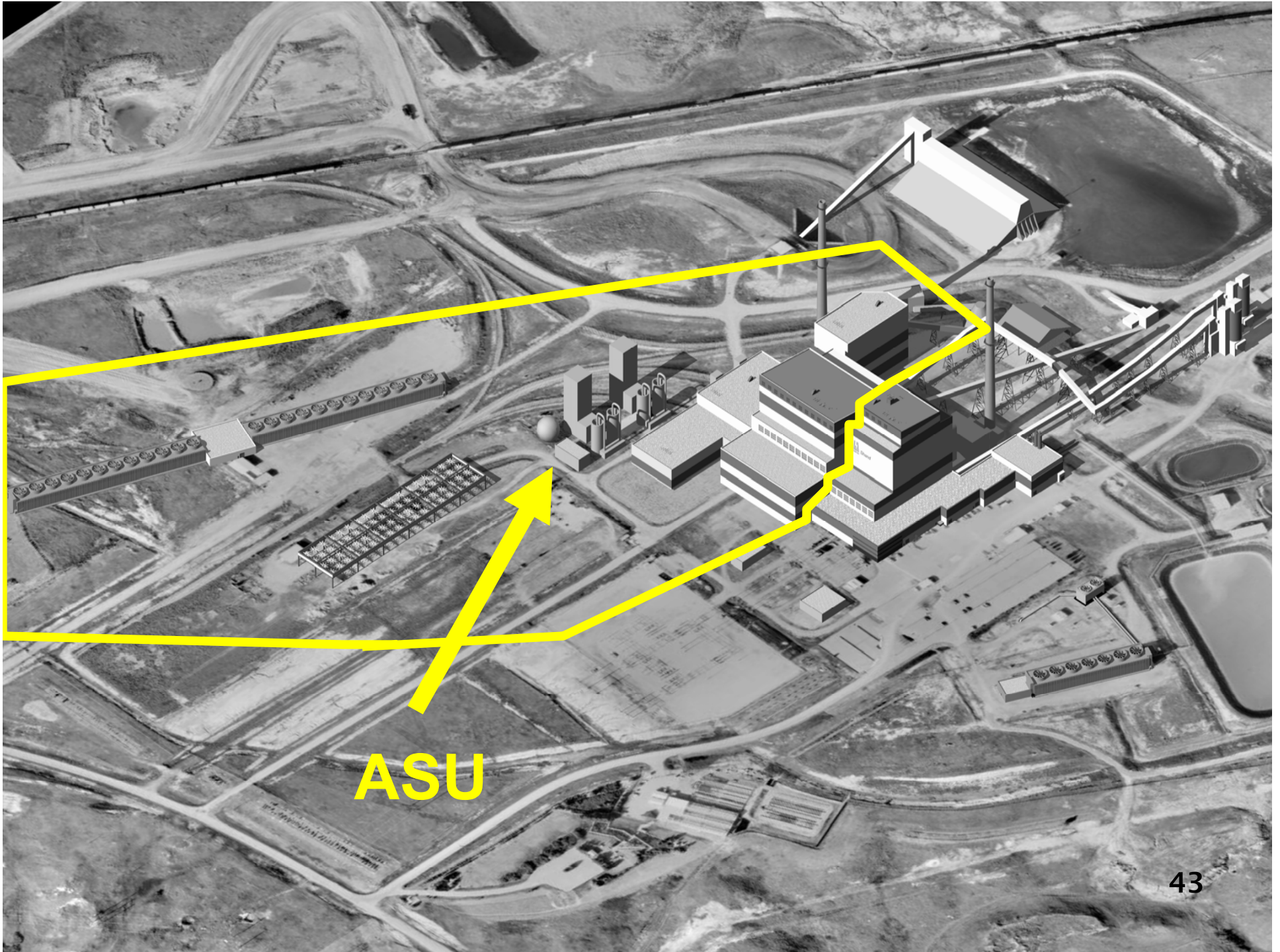




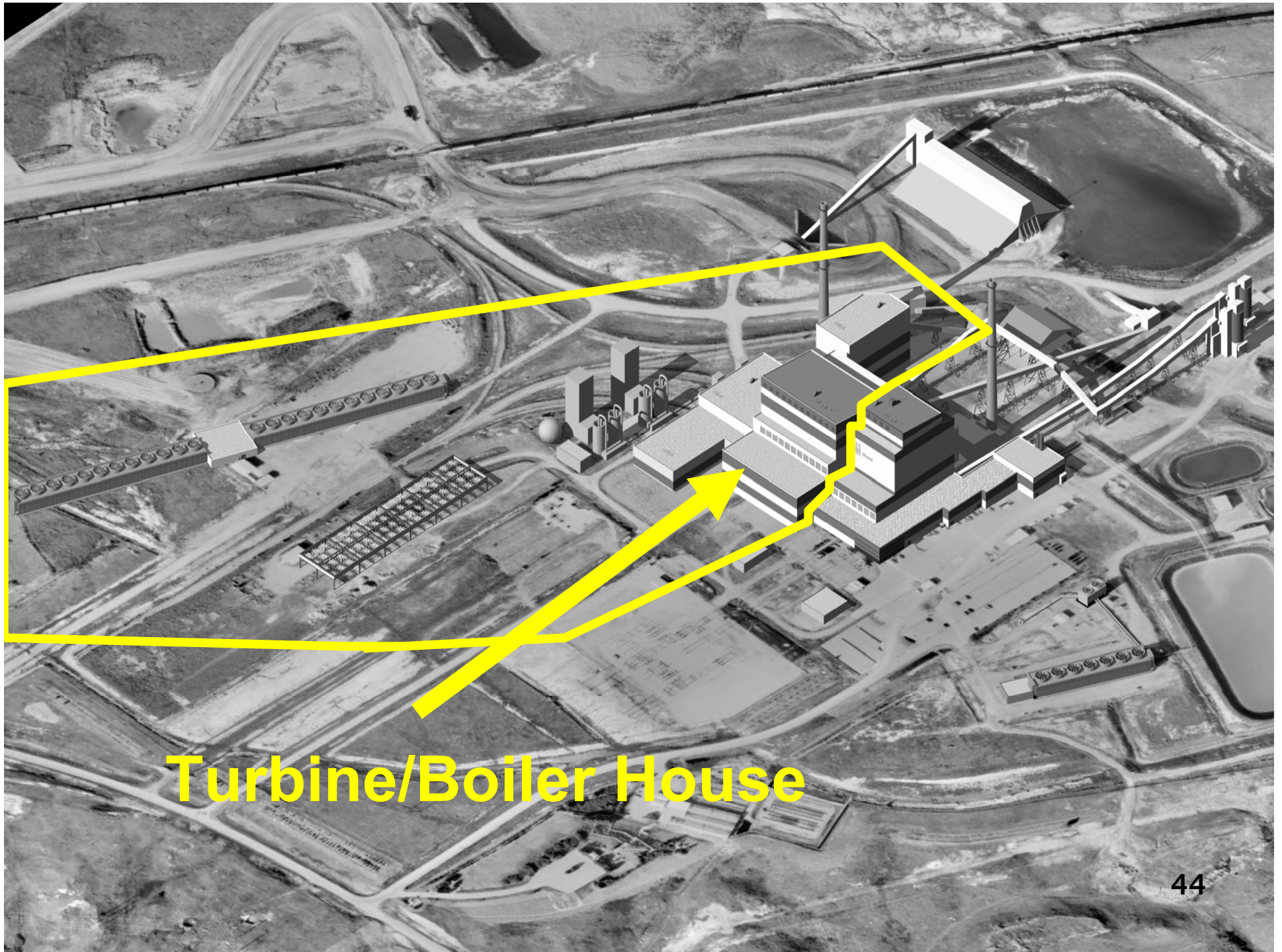
Existing Turbine/Boiler House



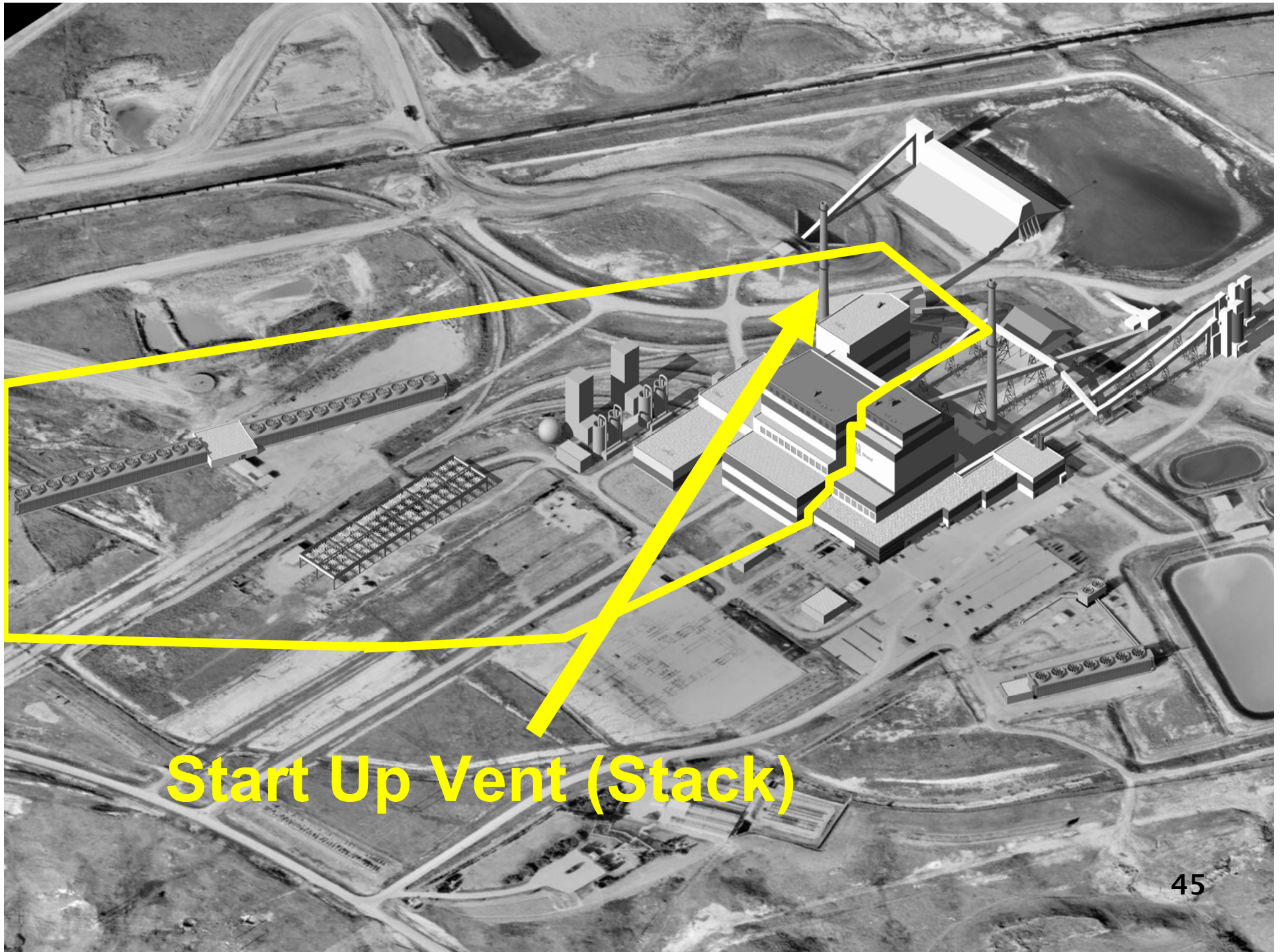
Heat
Rejection

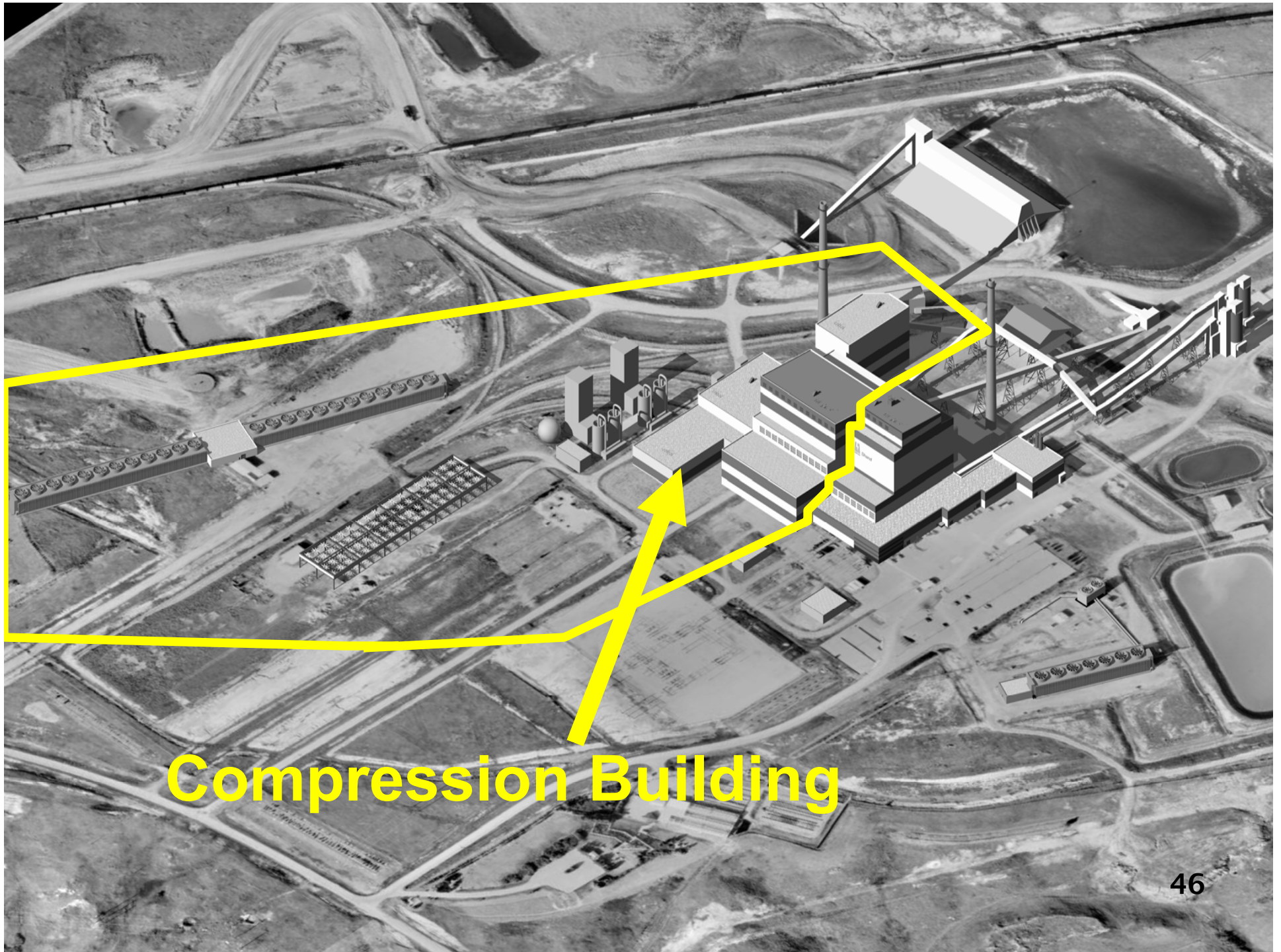


ASU



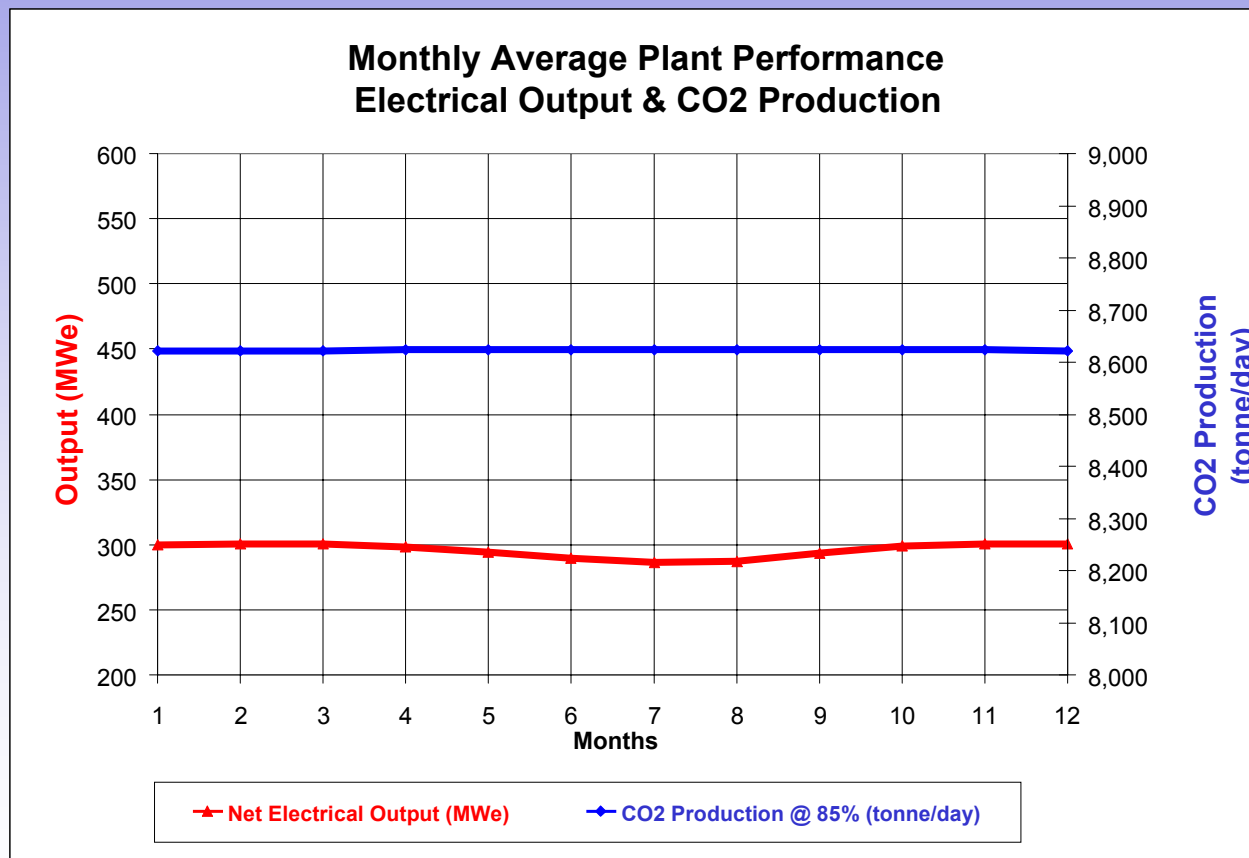
Turbine/Boiler House





Compression Building

Clean Coal Project – Technical Proposal: Plant Performance



Atmospheric Emissions Performance Comparison

	2006 Compliance ¹	Conventional Unit (Approved 1988)	Clean Coal
SO ₂ , kg/MWh	2.9	2.86	~ 0 ✓
NO _x , kg/MWh	0.69	2.86	0.02 ✓
Particulate Matter, kg/MWh	0.095	0.49	~ 0 ✓
Mercury, kg/TWh	15.0	-	~ 0 ✓
CO ₂ , kg/MWh	1000 (unregulated)	1044.0	44.0 ✓

1. These compliant guidelines reflect the current guidelines issued as New Source Emission Guidelines of the Canadian Environment Protection Act (CEPA) for SO_x, NO_x and PM, and the Canadian Council of Ministers of The Environment (CCME) Canada Wide Standard for Mercury.

Clean Coal Project – Technical Proposal: In-Service Date & Capacity Factor

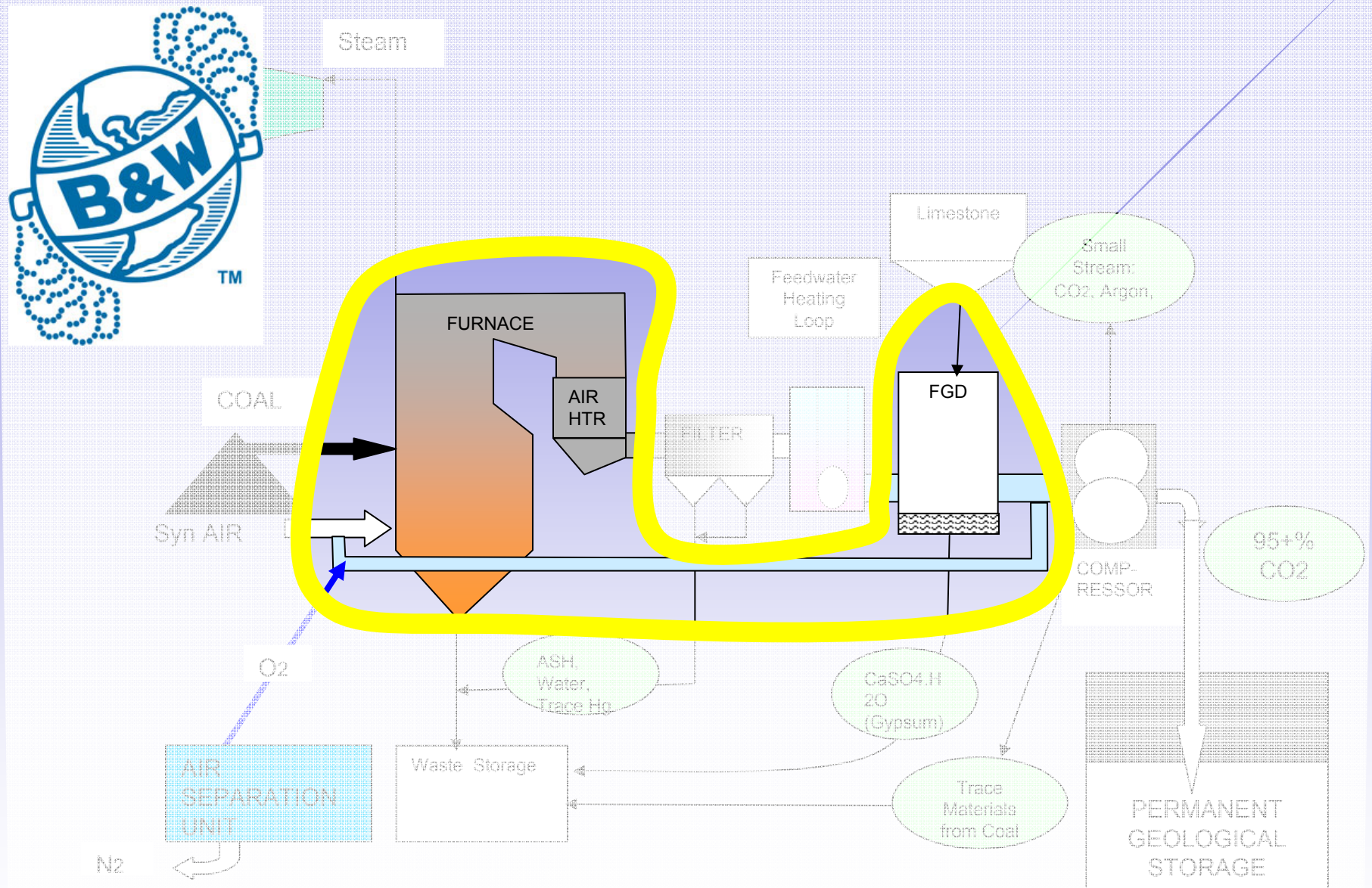
- Air Fired Operation Date
 - March 1, 2012
- Oxyfuel In-Service Date
 - September 1, 2012
- Forecast Capacity Factor
 - 85%

Clean Coal Project – Technical Proposal: Operating Costs

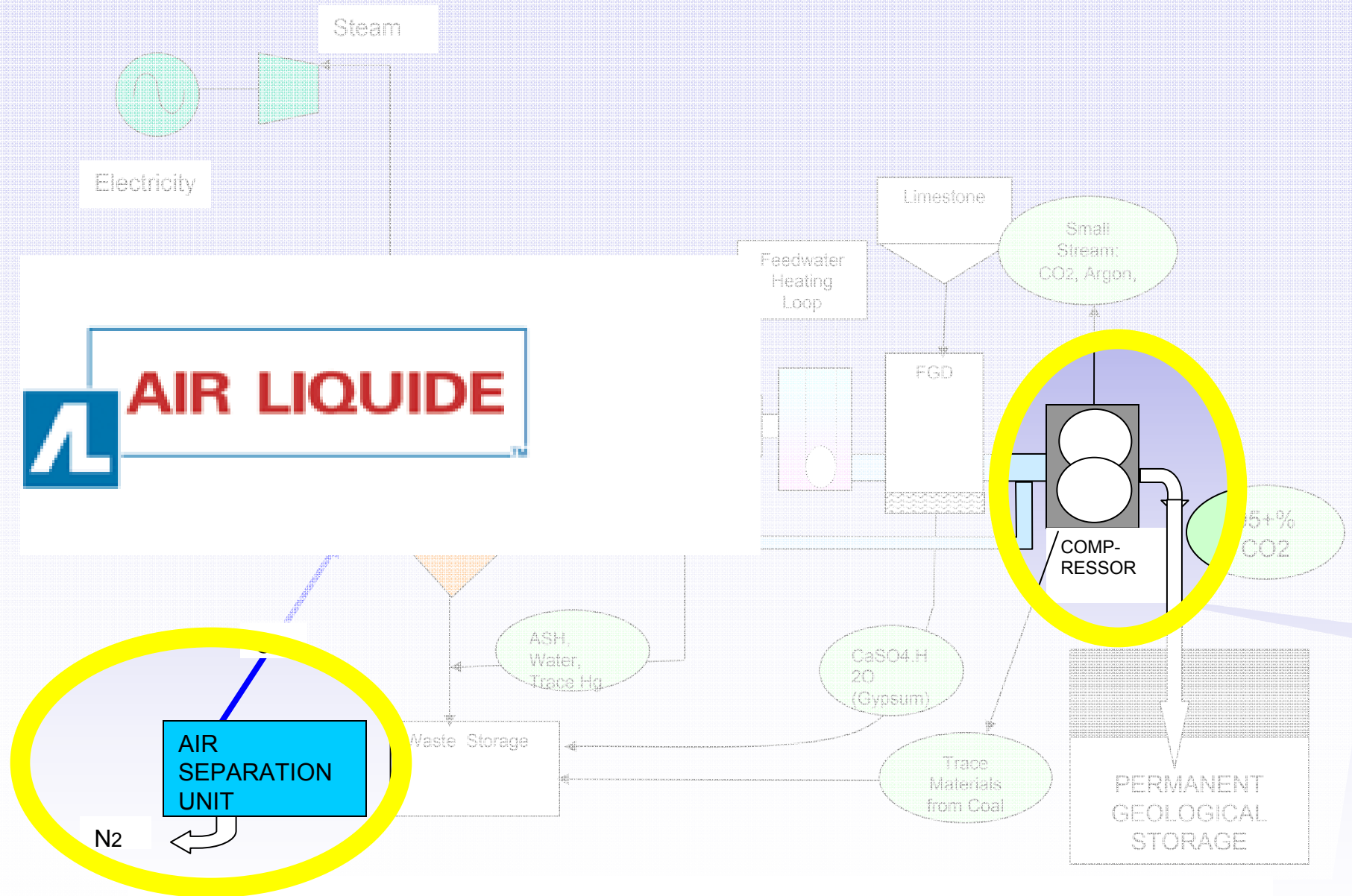
- \$26 million per year O&M cost
 - \$18 million fixed cost
 - \$3.80 variable cost/MWh
 - Life cycle capital costs also estimated
- Coal Requirements
 - 2.3 Mt per year
- Fuel Pricing
 - Fuel Supply has established coal price
 - Dragline pricing received

Clean Coal Project – Technical Proposal: CO₂ & Electrical Production

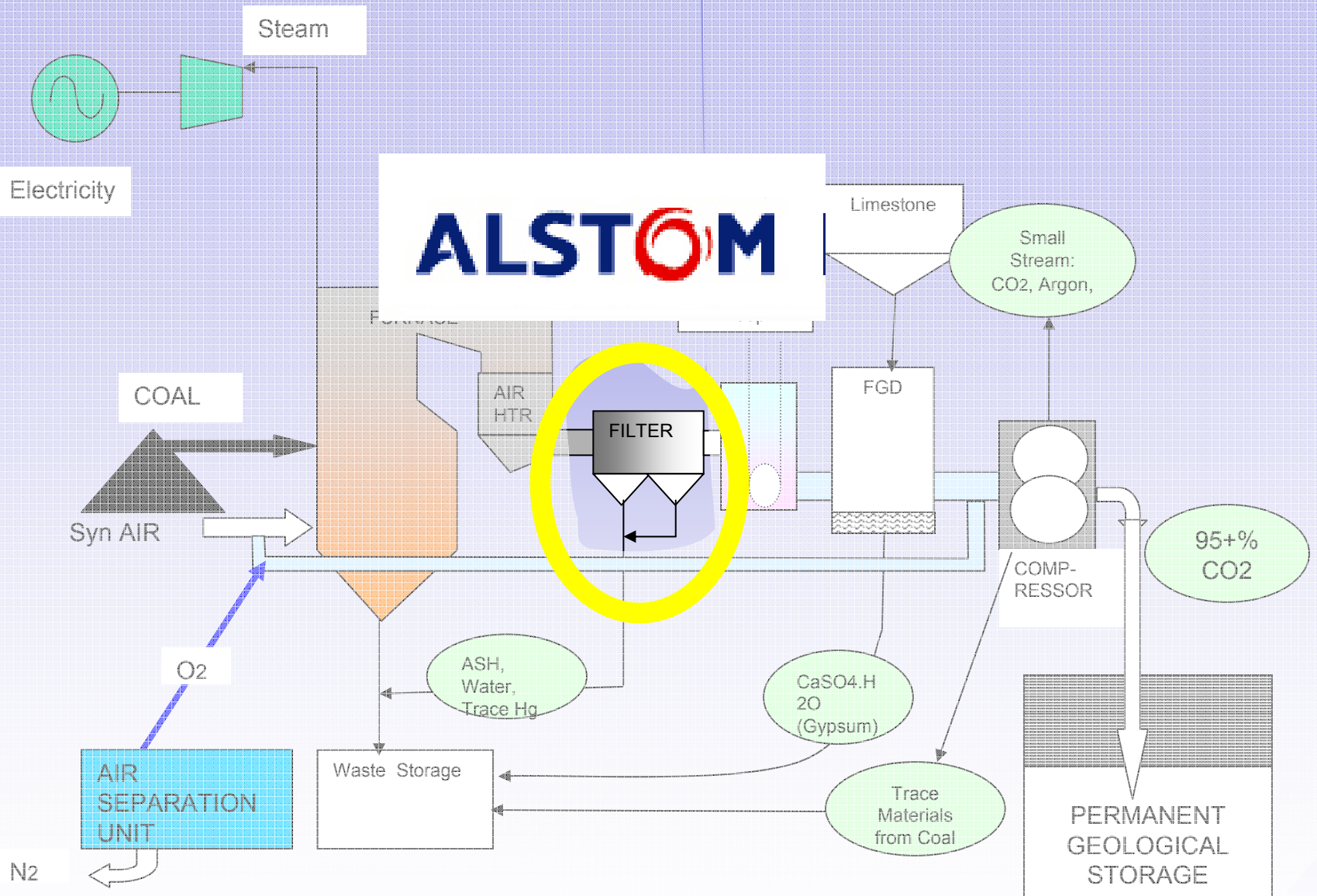
- Forecast Annual CO₂ For Sale
 - 3.15 million Mt per year - net
- Annual Electrical Production
 - 2.2 million MWh - net



SaskPower Oxyfuel Process



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Shand Site Rendering



Conceptual Risk Assessment

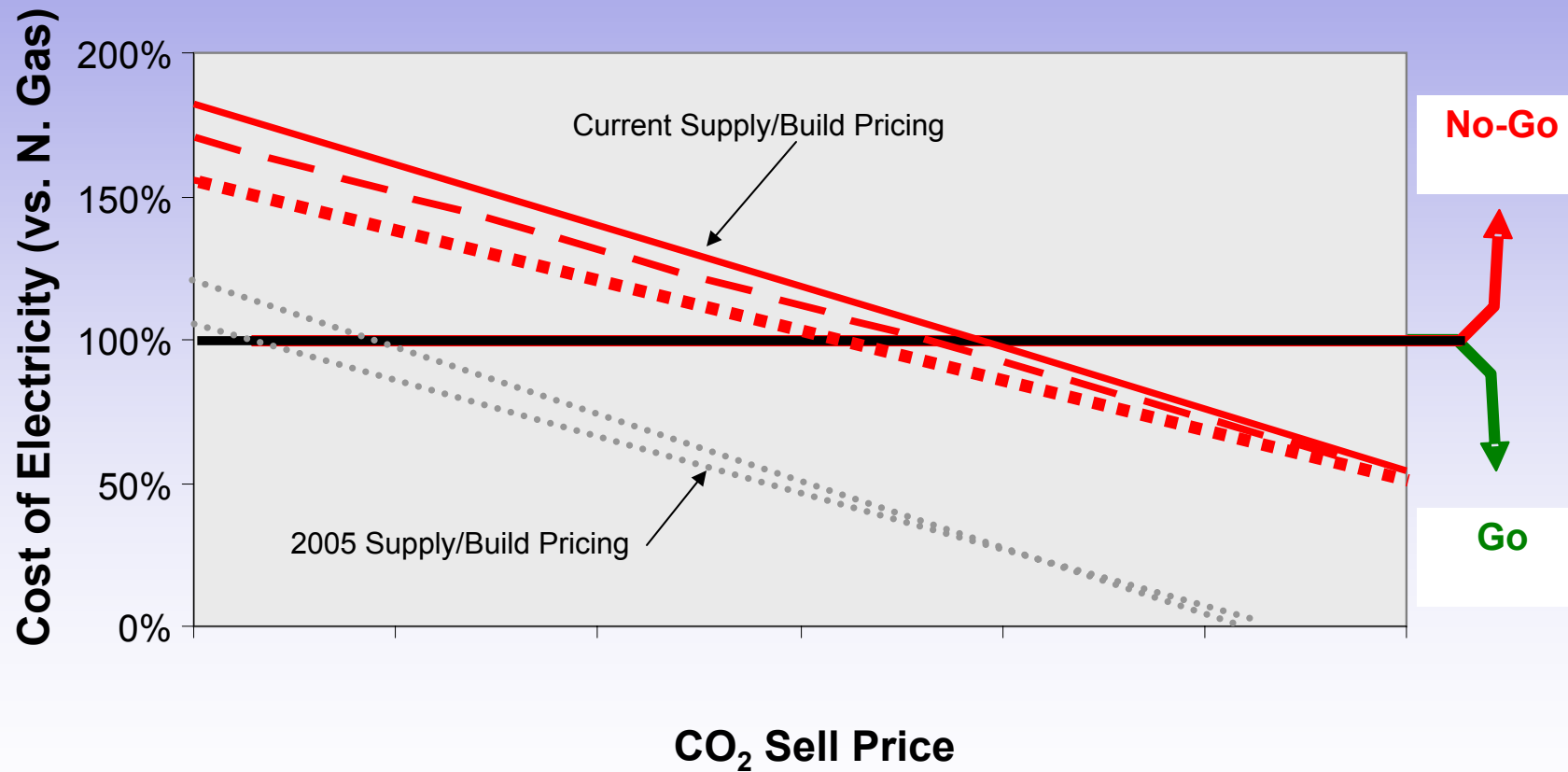
(Values are for demonstration only)

Issue	Clean Coal		Compliant Coal	
	Expected Loss	Maximum Exposure	Expected Loss	Maximum Exposure
Construction Labour	\$ 55,000,000	\$ 550,000,000	\$ 38,465,250	\$ 384,652,505
CO2 Sale Price	\$ 96,000,000	\$ 480,000,000	\$ -	
Electricity Sale Price	\$ 48,000,000	\$ 240,000,000	\$ 48,000,000	\$ 240,000,000
Change in Interest Rates	\$ 20,000,000	\$ 200,000,000	\$ 13,987,364	\$ 139,873,638
Long Term OM&A Costs	\$ 32,000,000	\$ 160,000,000	\$ 16,000,000	\$ 80,000,000
Technical Risks - Oxyfuel	\$ 34,375,000	\$ 137,500,000	\$ -	\$ -
Material Price Risk	\$ 25,000,000	\$ 100,000,000	\$ 17,484,205	\$ 69,936,819
GHG Regulations			\$ 240,000,000	\$ 960,000,000
	\$ 310,375,000	\$ 550,000,000	\$ 373,936,819	\$ 900,000,000



GHG Exposure for Compliant Coal may offset the project execution risks around "First Of" Clean Coal

Shand #2 CO₂ Cogen Plant - 2007 Supply/Build Prices



An aerial photograph of an industrial facility, possibly a refinery or chemical plant, with a 3D architectural model overlaid. The model consists of several large, rectangular, light-gray buildings with dark green horizontal stripes. Two tall, slender, gray smokestacks are positioned near the buildings. In the foreground, there are smaller, rectangular, light-gray structures and a network of pipes. The background shows a vast, flat landscape with green fields and a body of water under a hazy sky. The word "QUESTIONS?" is superimposed in large, bold, black capital letters across the center of the image.

QUESTIONS?

